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BOTANICAL SURVEY OF SOUTH AFRICA
MEMOIR No. 24

AN ECOLOGICAL ACCOUNT OF THE VEGETATION
OF THE
POTCHEFSTROOM AREA

By

W. J. LOUW, D.Sc.

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DEPARTMENT OF AGRICULTURE
Division of Botany and Plant Pathology
BOTANICAL SURVEY MEMOIR No. 24

AN ECOLOGICAL ACCOUNT OF THE VEGETATION OF THE POTCHEFSTROOM AREA

(With 3 maps and 39 illustrations being the thesis submitted in partial fulfilment of the regulations governing the award of the DSc. degree in the University of South Africa)

By

W. J. LOUW, D.Sc. (South Africa)

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THE GOVERNMENT PRINTER, PRETORIA
1951

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FOREWORD.

It gives me great pleasure to present for publication as a Botanical Survey Memoir this ecological account of the vegetation of the Potchefstroom area. Dr. W. J. Louw has taken an active interest in advancing botanical survey in the Union, first as a teacher in the Transvaal Education Department and later as a lecturer at the Teachers' College, Potchefstroom.

The present work is the culmination of over ten years study of the flora and vegetation of the Potchefstroom area. Like many other parts of the country it has suffered considerably from the impact of European civilisation. Dr. Louw emphasizes consistently the importance of biological relationships and introduces striking evidence of the rapid deterioration of vegetation cover and of the consequent soil erosion which takes place in mismanaged veld. Field officers in the Department of Agriculture particularly will find in this publication much instructive reading and it should have a wide general interest.

The three maps and excellent selection of photographic illustrations by the author himself are most useful adjuncts to the descriptive text. Another important point about this research is that Dr. Louw confirmed the identifications of his botanical specimens in the National Herbarium, Pretoria, where a comprehensive set of his duplicates is housed.

In conclusion of this Foreword I shall quote from Dr. J. Hutchinson, F.R.S., an external examiner of the thesis. " This thesis is an outstanding performance of the highest possible botanical merit and adds very greatly to our knowledge of the flora of the region and its relation to agricultural problems. Valuable biological notes are provided which have never before been made in South Africa ".

R. A. DYER,

Chief: Division of Botany and Plant Pathology and
Director of Botanical Survey for the Union of South Africa.

Pretoria,
20th May, 1950.

INTRODUCTION.

European settlement of this subcontinent commenced three centuries ago. New regions have repeatedly been added to the White Man's domain, and during the middle of the last century his control was finally established. The subsequent exploitation of the natural vegetation, indiscriminate farming practice for a century or more, and ignorance of the veld and its judicious management have resulted in the loss of soil and the general deterioration of its vegetation. This, again, has led to the lowering of the country's productive capacity, which, in turn, has a direct bearing on industrial expansion and large-scale immigration.

The soil and natural vegetation of a country provide the basic needs of human society; they are the foundation which supports the pillars of all enterprise: agricultural, industrial, commercial, cultural. Soil and vegetation are so interdependent that the destruction of one leads to the loss of the other. That the failure of recognising these basic truths leads to inevitable disaster, has been adequately and repeatedly demonstrated in history.

It is not necessary here to direct attention to the gravity of the situation in this country, nor is it possible to elaborate on what has already been said by such eminent authorities as the members of the Drought Investigation Commission, Dr. Ross, Dr. Bennett (1945)—to name but a few. " The Great South African Desert, Uninhabitable by Man " is not a chimera; it is the inevitable destination we are heading for unless we take the necessary action to avert it before more precious time has been frittered away.

The complex nature of the task requires concerted action and the enlistment of experts from various fields. Among these, the plant ecologist occupies a foremost position. He deals with the fundamental facts of the problem: the plant in its natural environment and its responses to different changes in the environment. More specifically, it is his task to make an inventory of the natural flora and to study the behaviour of the vegetation under various influences; only then can farming practice be so conducted that on the one hand the destruction of desirable plants is obviated, and on the other, the spread of undesirable plants prevented. It is with these considerations in mind that the present study was initiated, the outcome of which is presented in the following pages.

Where the plant ecologist leaves off, the practical research officer takes over; but their respective fields merge so imperceptibly into one another, that no clear boundary can be drawn. Although throughout the present work I have confined myself to the academic rather than the practical, I have often entered the field of applied botany with its agricultural implications. Such overlapping is perhaps not only justifiable, but desirable, for it presents views on the same problem as seen from different angles.

No extensive work on the flora of this area has been undertaken in the past. Sporadic collections of Burtt Davy, students of the Potchefstroom University College and others have been made which, however, constitute comparatively little, considering that Potchefstroom, founded in 1838, is the oldest European settlement in the Transvaal.

The need of intensive field work is obvious if we wish to present anything like a complete picture of a flora. To illustrate: in so recent a work as Burtt Davy's " Manual of the Flowering Plants and Ferns of the Transvaal and Swaziland " (1926, 1932), many genera and a large number of species of the Archichlamydeae represented in this area, have not be recorded; Phillips (1931) mentions only 28 genera of the Grasses for the Potchefstroom district, as against 59 genera listed in this work. Again, White and Sloane in their " Stapelieae " (1937), make mention of the fact that in the Flora Capensis (1909) not a single Stapeliad is recorded from the High Veld districts of the Transvaal south of Pretoria. Up to the time of publication of their own work, some of these districts have yielded a few Stapeliads, but not a single one was recorded from the Potchefstroom area; the present study, however, brought to light one *Caralluma*, one *Huernia* and one *Stapelia*. Yet no claim to completeness is made for the present survey; on the contrary, I am anticipating new additions to my list to appear from time to time.

My interest in the Potchefstroom flora was first aroused in 1937. During the succeeding years observations have been made in the field, and herbarium specimens have been prepared and identified. The work was, however, considerably intensified during the last five years, both in the field and herbarium.

I am personally responsible for the determination of the herbarium specimens of the phanerogamic plants, for which purpose I paid regular visits to the National Herbarium at Pretoria. In this herbarium, duplicates of the majority of specimens (including all of the less common species) are deposited for verification, should at any time the identity of any plant mentioned be questioned. The cryptogamic specimens were kindly dentified by the responsible botanists of the National Herbarium.

What is contained in the pages to follow, is based mainly on personal observation. In the course of the study many problems have cropped up which invite experimental investigation. This, however, would have taken ithe present work beyond its intended limits, as each is sufficiently comprehensive to warrant a separate study. For this reason too, no permanent transect and quadrat studies were incorporated in this work.

On the other hand, quadrat charts showing the effects of trampling and overgrazing by comparing the vegetation on each side of a fence, would have been very illuminating. The construction of such charts has been attempted several times, but in each case the grazing and trampling in the selected localities were so severe and the plants kept so short that correct identification of a large number of plants was not possible.

Three maps have been prepared on the same scale showing the geography, topography and geology of the area. The inclusion of a vegetation map was considered, but the various vegetation types were found to be so intimately connected with habitat that their distribution could be inferred from the maps supplied if used in conjunction with the text. Furthermore, as a result of sudden changes in the substratum, plant communities are frequently so scattered and so interspersed with others, that their location on a map would have been impracticable. This applies in particular to the hilly portion of the area.

Two taxonomic systems are in use in this country, Phillips' " Genera of South African Flowering Plants " (1926), which is based on Engler's system, and Goossens' " Suid-Afrikaanse Blomplante " (1940), which is founded on Hutchinson's system. Followers of the former maintain that their system has stood the test of time and that no need is felt for a new system of classification, while the Hutchinsonians argue that a vast number of species and genera have come to light since the time of Engler and Prantl, that our knowledge concerning the phylogenetic affinities between plants has made considerable progress, and that consequently a thorough reconsideration of the Plant Kingdom is imperative. In order to meet botanists of both schools, both classifications are shown in this work. The names of families printed in small letters denote the Goossens-Hutchinson classification, which is shown only where it differs from the Phillips-Engler system shown in capitals.

My sincere thanks and appreciation are tendered to all those who have directly and indirectly, and in various ways, rendered assistance without which the present study would not have been possible.

I am deeply indebted to Dr. R. A. Dyer, Chief of the Division of Botany and Plant Pathology, for facilities received and the hospitality enjoyed during my frequent and regular visits to the National Herbarium for the past ten years. To the members of his staff I am particularly grateful for assistance in clearing many taxonomical difficulties. Their numerous acts of kindness will always be recalled with appreciation.

To Drs. H. W. Turpin and J. W. Rowland of the Division of Agricultural Education and Research I owe a special debt of gratitude for financial assistance granted by their Division which covered my travelling expenses during the past two years.

To Dr. R. A. Saunders, formerly Senior Research Officer at the Potchefstroom Agricultural College, I am grateful for permission to reproduce from his publication Table II and Figure I in the present work.

To Prof. A. P. Goossens, my Promoter, who has shown a keen interest in the work in all its phases, and to Dr. P. J. Botha of the Potchefstroom University College, I wish to express my sincere thanks for reading through the manuscript and offering valuable suggestions.

To Mr. J. W. Daneel, M.A., Senior Lecturer in English at the Potchefstroom Teachers' College, I owe a debt of thanks for reading the manuscript and suggesting certain alterations; also to Mr. P. B. Ackermann, M.Sc., of the Department of Geology, Potchefstroom University College, for reading Chapter I.

CHAPTER I.

TOPOGRAPHY AND GEOLOGY.*

The area under consideration in the present work comprises the whole of the Potchefstroom Magisterial District and the southern and eastern portions of the districts of Ventersdorp and Klerksdorp respectively, totalling roughly 1,750 square miles. It extends from latitude 26° 15′ to 27° 0′ south and from longitude 26° 50′ to 27° 31′ east, representing a western portion of the great inland plateau, the High Veld.

The topography and geology of the area are so intimately interrelated that separate treatment would hardly be possible. The great diversity of geological formations accounts for the variety of scenery and surface features, which in turn, determine the nature of the vegetation.

Geologically, the area possesses a remarkable range of strata and a variety of intrusive rocks; in fact, most of the geological formations of the Transvaal, ranging in age from the Primitive Older Granite to the Recent Gravels, are represented within its limits. The bulk of the rocks are probably pre-Cambrian in age. A few small isolated inliers of the horizontally bedded Ecca Series are the only representatives of the late Palaeozoic rocks.

The foundation rock is Older Granite, on which rest in upward succession the Witwatersrand, Ventersdorp and Transvaal Systems. The fourth and most recent is the Karroo System which, in this area, however, has been completely removed by erosion, except for a few isolated remnants of the Coal Measures (Ecca Series).

A glance at the geological map reveals a remarkably symmetrical arrangement of formations about a N.E.-S.W. axis coinciding with a great syncline in the Transvaal beds, which may be regarded as the main structural feature of this area.

The Older Granite indicated on the map north of Parys forms part of the central granite core of the unique phenomenon, known as the Vredefort " dome ". Around this core, not only the Witwatersrand beds which lie in close proximity, but practically the whole of the Ventersdorp and Transvaal Systems as well, are arranged in concentric fashion, with the strata dipping towards the centre, though in inverted order. The curving, folding, crumpling and overturning of the beds concerned, the presence of igneous material and the great variety of metamorphic minerals are evidence of violent tectonic disturbances in the past, the topographic expression of which is the rugged mountainous scenery, part of which is shown in the south-eastern corner of the map.

The area occupied by Older Granite is characterised by fairly level or gently undulating ground. With the exception of occasional outcrops of varying size, the granite is concealed below a cover of light, sandy soil.

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* The information contained in this Chapter was drawn mainly from A. L. du Toit's "Geology of South Africa" (1939) and Explanations of Sheets Nos. 53 and 61 of the Geological Survey, Department of Mines, Union of South Africa (1935; 1939).

The Witwatersrand System.—Bordering on the granite plain, and in striking contrast with it, is the impressive mountainous scenery composed of the various layers of the Witwatersrand System. The ridges, of varying elevation, up to 1,000 feet above the level of the Vaal River, are arranged in broad, concentric arcs, separated by deep valleys. The Witwatersrand System, which consists mainly of alternating layers of quartzite and argillaceous sedimentary rocks with intrusive diabase sheets, is completely exposed in this area and the rugged landscape is the result of differential weathering, leaving the more resistant quartzites more or less intact. The hills and ridges are often thickly wooded, especially in the kloofs and ravines.

In the diagonally opposite corner of the map, the Witwatersrand System is topographically much less impressive, and is represented by its lowermost beds only, viz. the Dominion Reef and Hospital Hill Series. The rather irregularly scattered hills and low ridges which constitute the characteristic features of the landscape, represent the most elevated portions of an irregular floor of the Lower Witwatersrand beds, on which the Ventersdorp lavas were deposited in pre-Cambrian times. The subsequent removal by denudation of these Ventersdorp rocks has again exposed the beds of the Witwatersrand System.

The Ventersdorp System.—The Ventersdorp era was marked by great volcanic activity, hence the rocks included in the System are predominantly of igneous origin. The basic lavas form the most important member of the system and, in the area under review, the chief representative type. It is highly amygdaloidal, hence the name Ventersdorp amygdaloid or amygdaloidal diabase. It is a bluish-grey rock, with a brownish or reddish weathered crust, and the amygdales, which may be abundant, sparsely scattered or sometimes absent, are usually of quartz, though other minerals may also be represented.

In the south-eastern corner of the map a continuous zone of uniform width is occupied mainly by amygdaloidal lavas. Here they give rise to a more or less continuous range of broad, swelling hills of considerable elevation which constitute a watershed between the tributaries of the Loopspruit and the Mooi River, and the smaller streams which join the Vaal River more directly. The characteristic feature of these hills is their smooth and broadly rounded outline.

The same formation occurs again along the north-western boundary of the area, but here the rocks fail to produce any prominences in the landscape, and the ground surface is flat or gently undulating. Adjoining this strip, there are two smaller patches of bedded tuffs and tuffy sediments belonging to the Ventersdorp System (not shown on the map).

The Transvaal System.—This system occupies large tracts of country and plays an important rôle in the topography of the area. Its most important representatives are the Dolomite Series, characterised by the wide, open country and the Pretoria Series which builds the Gatsrand escarpment in the north-east. The lowermost member of the system, the Black Reef Series, occurs as two very narrow strips along the outer margins of the Dolomite and is relatively unimportant in the area (not shown on the map).

The Dolomite is overlain by the Pretoria Series and exposed on either side of the great syncline formed by the Transvaal beds. A typical Dolomite landscape is practically treeless, flat and monotonous, relieved only by irregularly scattered low and broadly rounded chert rises. The soil is usually shallow and stony and covered with a very heterogeneous vegetation of sour grasses and other herbs, and ill-suited to practically any form of agricultural exterprise, as is evidenced by the widely scattered homesteads.

The formation is composed almost entirely of magnesian limestones with subordinate bands of chert. By removal of the soluble calcareous portions, the siliceous or chert nodules and ribs stand out from the surface. The result is a curiously wrinkled and pitted surface of the exposed rock. Similarly, the chert rises, which consist of a rubble of angular chert stones of varying shape and size, owe their existence to the solubility and removal of the carbonates. Such a formation has an excellent downward drainage, which accounts for the fact that the surface drainage system is poorly developed in the Dolomite areas.

Another striking feature of the Dolomite is the occurrence of numerous subterranean caves in areas where the content of soluble carbonates is high and the supply of underground water abundant. In the country around Welverdiend and Oberholzer these are said to extend uninterruptedly for several miles. When any part of such a cave widens beyond a certain limit, as the result of underground erosion, the roof collapses and a sinkhole is formed. Sinkholes varying in size from a few square yards to several acres and of all ages, are scattered throughout the Dolomite zone.

The abundance of joints and solution channels enables great volumes of water to be held in the dolomite. The larger springs, not only in this area but far beyond its boundaries, issue from this formation. The constancy of these springs is remarkable. According to the water superintendent for, Bank and Oberholzer they remain unaffected by even very prolonged periods of drought and during his period of office, nearly 20 years, their output has never varied from month to month or from year to year. Seepage of underground water is practically impossible owing to the compact, impervious nature of the rock. Subterranean passage is therefore restricted to solution channels following bedding planes and joints—a condition which renders water-boring highly uncertain, as is shown by the high percentage of failures on record.

The various groups comprising the Pretoria Series consist mainly of quartzites and shales in alternating succession, and in contrast with the Dolomite Series, show prominent relief. The shales and instrusive diabases form the valleys and depressions, while the more resistant quartzites give rise to a series of well-defined ridges. The most imposing of these is the Gatsrand following an east-westerly trend with comparatively steep northern slopes. From any of the projecting peaks a long range view can be obtained over the low-lying Dolomite plain to the north.

Towards the west the range gradually loses prominence and continuity; to the north of Potchefstroom it is interrupted by folding and faulting, which brings in a tongue of Dolomite to the west of the railway. To the west of Klington Siding, however, the range is continued as a broken line of hills extending as far as Machavie Station, beyond which point the Pretoria quartzites cease to be of topographic importance.

The quartzites of the Pretoria Series on the south-eastern limb of the major syncline have been repeated many times as a result of complicated folding—thus giving rise to several more or less parallel ridges.

The whole area is drained by the Vaal River and its tributaries, of which the Mooi River and Loopspruit are the most important. The latter has its origin near Losberg and follows the trend of a valley which coincides with the major syncline of the Transvaal beds already alluded to.

The average width of this valley is eight miles and it is characterised by heavy alluvium deposits of great depth. The Loopspruit is now entirely dependent on rain for its flow and is therefore unable to support a vegetation with all-the-year-round water demands. Two dams in its bed, one at Vyfhoek and one at Klipdrift, retain water throughout the year.

The Mooi River, on the other hand, is a perennial stream, fed by a number of strong springs or " eyes " in the Dolomite formation, within and beyond the northern limits of the area. The town of Potchefstroom is situated on its banks just above its junction with the Loopspruit. A never-failing water supply accounts for the concentration of population at suitable spots along the entire length of the Mooi River and the Wonderfontein Loop. Above Potchefstroom, the alluvial strips along its banks are comparatively narrow; nevertheless at farms like Naauwpoort, Welverdiend and Wonderfontein, irrigation farming is practised on a fairly extensive scale.

Besides these two streams, there are numerous spruits of varying length and capacity, which either discharge into the Vaal River directly or help to swell the waters of its tributaries during the rainy season.

CHAPTER II.

CLIMATE.

RAINFALL.

Precipitation occurs mainly in the form of rain, though hail is not infrequent. Sleet has fallen only on rare occasions. Thunderstorms are common, especially during the opening months of the season, and even the continuous soaking rains are often preceded by thunder conditions. Such storms are usually of short duration and the precipitation may be slight or heavy; if accompanied by hail, the results are often devastating. Rains derived from thunderstorms are as a rule of a local nature and scattered over a wide area. About 85 per cent. of the average rainfall occurs during the six summer months from October to March. (Fig.I.)

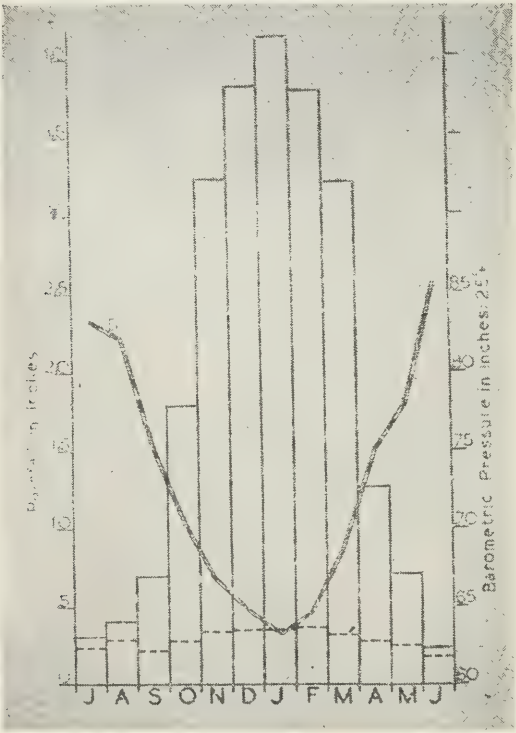

FIG. I.

Monthly distribution of the rainfall and mean barometric pressure (B), 1903–1904 to 1940–1941. (Transferred from Saunders, 1942.)

TABLE I.

MONTHLY RAINFALL TOTALS AND NUMBER OF DAYS ON WHICH RAIN FELL.

Year.	Station.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
		Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.
1926	Potchefstroom	3·54	15	4·39	11	3·30	11	0·63	5	0·45	4	0·77	2	0·67	1	0·00	0	0·37	2	1·57	8	1·20	11	*4·94*	13	21·83	83
	Welverdiend	*5·99*	12	3·73	9	3·93	10	0·73	2	1·53	3	0·00	0	0·52	1	0·00	0	0·40	1	1·95	5	3·21	7	4·82	13	26·81	63
	Parys	*4·62*	10	4·45	7	2·48	9	0·55	3	0·58	2	0·78	2	0·42	1	0·00	0	1·34	2	1·77	6	1·95	7	2·39	6	21·33	55
1927	Potchefstroom	2·06	10	3·51	8	*6·85*	19	0·01	1	0·02	1	0·00	0	1·45	3	0·17	1	0·00	0	1·70	4	0·56	6	1·50	11	17·83	64
	Welverdiend	2·19	7	2·65	9	*5·47*	13	1·63	5	0·00	0	0·00	0	1·03	2	0·04	2	0·08	1	2·46	8	3·02	5	3·82	11	22·39	63
	Parys	3·24	6	*3·79*	8	2·48	8	0·51	3	0·00	0	0·00	0	1·45	3	0·00	0	0·00	0	1·77	5	1·36	6	1·61	7	16·21	46
1928	Potchefstroom	*5·58*	15	2·87	13	2·87	8	0·84	5	0·00	0	0·16	2	0·00	0	0·38	3	1·36	3	1·92	5	4·37	8	2·20	10	22·55	72
	Welverdiend	*7·92*	12	4·98	8	3·57	8	1·82	5	0·04	1	0·35	1	0·00	0	0·21	1	0·39	4	1·52	2	5·86	9	2·77	11	30·43	62
	Parys	*6·00*	11	2·99	8	2·28	5	1·05	3	0·15	2	0·15	1	0·00	0	0·10	1	0·85	3	3·14	6	5·14	9	0·84	3	23·69	52
1929	Potchefstroom	*9·09*	13	2·88	7	4·63	10	1·24	2	1·35	3	2·37	4	0·12	2	0·03	1	2·71	10	1·87	8	6·08	14	4·62	12	36·99	86
	Welverdiend	*6·45*	15	5·01	7	3·34	12	—	—	1·25	5	1·14	5	0·00	0	0·01	1	3·05	9	4·05	11	6·18	16	5·49	11	(36·07	92)
	Parys	4·27	8	2·30	5	5·01	10	0·96	3	0·91	3	4·33	5	0·28	1	0·01	1	3·83	10	1·22	8	*5·19*	11	4·73	12	33·04	77
1930	Potchefstroom	*6·27*	14	3·49	6	3·35	9	0·75	4	0·44	2	0·06	1	0·10	2	0·67	1	0·00	0	0·69	4	0·93	6	3·93	15	20·68	64
	Welverdiend	*7·10*	14	2·91	7	3·02	7	0·02	1	0·76	2	0·00	0	0·58	2	0·40	1	0·00	0	0·54	4	2·46	8	5·40	13	23·19	59
	Parys	*5·33*	11	4·24	6	2·43	6	1·85	4	0·35	1	0·10	1	0·00	0	0·68	1	0·01	1	1·38	4	0·94	6	3·30	10	20·34	51
1931	Potchefstroom	*5·41*	16	3·55	10	3·12	7	3·94	6	0·00	0	0·00	0	0·40	3	0·00	0	0·00	0	1·20	4	4·49	10	3·50	9	25·61	65
	Welverdiend	*10·53*	9	1·81	6	1·26	3	3·02	7	0·00	0	0·00	0	0·45	3	0·00	0	0·00	0	1·55	3	2·55	13	3·62	12	24·79	56
	Parys	3·52	9	3·59	5	2·57	6	3·78	7	0·00	0	0·00	0	0·38	3	0·00	0	0·00	0	2·18	6	*5·71*	8	2·28	3	24·01	47
1932	Potchefstroom	2·40	9	*5·69*	17	1·98	6	0·96	3	0·00	0	0·08	1	0·00	0	0·00	0	0·58	1	0·42	5	1·64	10	3·12	11	16·87	63
	Welverdiend	2·31	9	4·84	14	2·85	6	0·60	2	0·02	1	0·05	1	0·00	0	0·00	0	0·52	2	1·07	4	2·68	10	*6·32*	14	21·26	63
	Parys	1·29	4	*4·32*	11	2·09	4	1·02	3	0·00	0	0·00	0	0·00	0	0·00	0	0·95	2	1·11	5	1·69	5	4·03	12	16·50	46
1933	Potchefstroom	1·14	9	4·03	6	1·42	5	1·45	6	0·01	1	0·02	1	0·00	0	0·00	0	0·56	1	0·56	6	*4·98*	16	4·64	14	18·81	65
	Welverdiend	1·79	8	3·50	5	2·22	5	1·15	4	0·35	2	0·08	1	0·00	0	0·00	0	0·32	1	0·63	6	*10·32*	17	4·70	8	25·06	57
	Parys	1·48	5	1·15	6	1·84	7	1·29	4	0·00	0	0·13	1	0·00	0	0·00	0	0·64	1	0·39	4	*8·88*	7	6·54	12	22·34	57
1934	Potchefstroom	*9·45*	18	2·04	8	3·51	10	1·10	6	2·05	7	0·23	2	0·16	2	0·39	3	0·38	2	2·10	6	6·38	14	4·88	11	32·67	89
	Welverdiend	4·62	7	3·41	6	1·96	7	0·62	4	1·54	5	0·13	2	0·24	2	0·45	2	0·75	2	2·54	5	*6·43*	11	5·33	10	28·02	63
	Parys	*9·68*	17	2·04	2	2·97	8	1·53	7	2·14	5	0·12	1	0·25	3	1·46	2	0·13	1	3·07	5	8·22	7	3·78	8	35·39	66
1935	Potchefstroom	1·57	8	1·62	9	5·73	15	0·70	7	0·31	2	0·01	1	0·00	0	0·33	1	0·12	3	0·82	5	0·99	6	*5·87*	13	18·07	70
	Welverdiend	0·94	3	*4·59*	11	3·76	11	0·86	5	0·30	3	0·00	0	0·00	0	0·20	1	0·47	3	1·88	7	0·74	5	4·26	10	18·00	59
	Parys	3·27	4	2·00	9	*8·26*	11	0·78	3	0·31	1	0·00	0	0·00	0	0·16	1	0·43	3	1·87	4	1·40	3	4·02	9	22·50	48
1936	Potchefstroom	2·05	12	6·49	10	*6·47*	12	0·27	1	3·88	8	0·00	0	0·00	0	0·00	0	0·00	0	1·70	5	6·69	13	3·81	5	31·63	66
	Welverdiend	5·39	13	3·50	10	3·53	11	1·22	2	3·95	6	0·00	0	0·00	0	0·00	0	0·04	1	1·80	9	*6·12*	16	3·20	7	28·75	75
	Parys	3·73	6	4·90	11	5·86	10	0·81	3	3·60	6	0·00	0	0·00	0	0·00	0	0·00	0	1·42	6	*11·70*	15	1·84	6	33·86	63
1937	Potchefstroom	*4·46*	14	3·17	10	1·16	8	0·61	3	0·15	1	0·00	0	0·00	0	0·00	0	0·00	0	0·76	2	0·80	3	3·50	13	14·61	54
	Welverdiend	4·16	16	4·98	13	1·74	9	1·47	6	0·03	1	0·00	0	0·00	0	0·00	0	0·24	2	1·35	4	2·49	10	*6·24*	16	22·70	77
	Parys	3·05	10	2·82	7	1·33	5	1·97	3	0·00	0	0·00	0	0·00	0	0·00	0	0·00	0	1·83	2	1·36	5	*6·36*	12	18·72	44
1938	Potchefstroom	3·34	11	2·78	11	1·04	4	2·13	6	0·41	2	0·51	5	0·18	1	0·39	3	0·06	1	2·46	13	1·18	4	*5·30*	10	19·78	71
	Welverdiend	5·42	13	*8·47*	15	0·93	8	3·53	7	1·50	3	0·46	3	0·30	1	0·63	4	0·72	2	3·18	10	0·94	5	6·82	17	32·90	88
	Parys	4·64	11	4·17	12	3·81	3	5·29	8	0·36	2	0·74	5	0·00	0	0·46	3	0·06	1	3·70	13	1·83	4	*5·78*	15	30·84	77
1939	Potchefstroom	4·52	12	*6·96*	11	4·44	12	0·00	0	1·21	4	0·03	1	2·51	6	0·36	1	0·24	3	1·78	9	4·45	9	2·05	9	28·55	77
	Welverdiend	4·59	16	7·28	15	*8·12*	12	0·00	0	0·55	2	0·08	1	1·92	7	1·20	4	1·60	3	3·01	10	5·60	12	3·33	10	37·28	92
	Parys	6·21	17	*8·52*	18	2·99	12	0·06	1	1·70	5	0·11	2	3·09	5	0·89	3	0·24	2	1·41	9	3·64	7	3·34	8	32·20	89
1940	Potchefstroom	2·29	7	3·88	9	3·25	12	0·87	5	0·75	4	0·54	3	0·00	0	0·17	1	3·67	8	0·50	3	2·51	4	*4·68*	11	23·11	67
	Welverdiend	2·08	8	3·06	10	2·63	11	1·25	6	1·12	2	0·99	3	0·00	0	0·35	2	2·99	10	0·68	3	2·72	8	*3·60*	10	21·47	73
	Parys	2·47	9	1·33	7	3·58	11	1·31	7	1·17	4	0·49	4	0·00	0	0·04	1	2·16	8	0·24	2	4·68	7	*7·07*	10	24·54	70

Italicised figures indicate the highest monthly rainfall for the year.
Yearly averages for the 15-year period 1926–1940 (incl.): Potchefstroom, 23·31 ins. 70 D.; Welverdiend, 26·61 ins. 69 D.; Parys, 25·03 ins. 59 D.

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Although a considerable proportion of the annual precipitation is patchy, the distribution throughout the area, taken over a number of years, is fairly uniform, as is shown in Table I. Of the three stations selected, Potchefstroom and Welverdiend are located in the central and northern portions of the area respectively; the third, Parys, is just off the southern boundary. The slight variation in the average rainfall is to be expected considering the relatively flat topography and slight differences in altitude.

The inadequacy of yearly rainfall records as a quantitative expression of holard, and hence their indicator value as to the nature of the vegetation in any particular region, has been noted by several authors. In order to present a complete picture, records must reflect the conditions which are critical to the vital functions of the plant: germination, ecesis and seed-production. Monthly totals furnish a better clue than yearly totals, since they reveal to some extent the extreme conditions regarding the presence of water in the soil, i.e., droughts and floods.

Although the average annual precipitation may appear to be adequate for the average farming requirements, its effectiveness is greatly reduced by the following factors:—

(1) *Distribution*.—The records for Potchefstroom (Saunders, 1942) show an average seasonal rainfall of 23·63 inches for the period 1903–04 to 1940–41, but the figures ranged from 34·60 inches for 1924–25 to 13·85 inches for 1932–33. The irregularity of the monthly and seasonal distribution is evident from the figures shown in Table I. For November, for instance, which is a very critical month to crop and pasture alike, the range of variation during the 15-year period has been as follows: Potchefstroom, 0·56–6·69 inches; Welverdiend, 0·74–10·32 inches and Parys, 0·94–11·70 inches.

Table II further illustrates the variability of the rainfall in a very striking manner. The third column shows the monthly and yearly limits of variation for the period 1903–41. But the unreliability of the rainfall is perhaps best illustrated if the average deviation is expressed as a percentage of the mean (fourth column). Thus, while the average yearly deviation of the rainfall was 16·5 per cent., the lowest for any month was 35·9 per cent. During the winter months the rainfall is not only the lowest but at the same time the most uncertain.

The erratic distribution of rainfall results in excesses at one time and deficiencies at another; the latter, if they occur at a time when rain is most needed, constitute perhaps the most important single cause of farming losses. It frequently happens that spring showers are separated by too long intervals of drought to continue the growth of grass which has been stimulated by the rise in temperature, and the result is an alternation of sprouting and wilting.

Dryland crops, of which maize is the most important, are affected by droughts mainly in three ways: (*a*) Insufficient spring rains delay ploughing and planting and necessitate the growing of early varieties which will mature before the coming of the first frosts, but the crop is thereby much reduced on account of the lower yield of such varieties. (*b*) The dry period may coincide with the flowering stage of the crop—the most critical stage in the life-history of the maize plant. (*c*) Maize planted late in the season is more subject to the ravages of the stalk-borer than when planted earlier.

TABLE II.

EVAPORATION, NUMBER OF RAIN DAYS AND VARIATION IN RAINFALL, 1903–41.

(Average deviations were computed by finding the differences, irrespective of sign, between mean values and totals of rainfall for every month or every year over the whole period under review, adding and dividing by 38, the number of hyetal years.)

Taken from Saunders (1942).

Month.	Mean Rainfall (Inches).	Mean No. of Rain Days.	Limits of Variation in Inches of Rain.		Average Deviation of Rainfall.		Evaporation from Free Water Surface.	
			Lower.	Upper.	Inches.	Per Cent. of Mean.	Inches.	Per Cent. of Rainfall.
July......	0·31	1·3	·00	3·27	0·41	132·3	2·98	961
August....	0·41	1·4	·00	3·92	0·53	129·3	4·43	1,080
September	0·70	3·2	·00	3·67	0·63	90·0	6·18	883
October...	1·79	6·4	·03	6·75	0·97	54·2	7·84	438
November.	3·23	9·4	·36	6·69	1·45	44·9	8·13	252
December.	3·83	10·9	1·00	9·32	1·45	37·9	7·22	189
January...	4·14	12·0	·72	9·47	1·65	39·9	6·91	167
February..	3·79	10·1	·87	8·94	1·36	35·9	5·65	149
March....	3·21	9·9	·44	10·87	1·55	48·3	5·39	168
April.....	1·27	4·5	·00	5·30	0·92	72·4	4·20	330
May......	0·71	2·8	·00	3·88	0·64	90·1	3·44	485
June......	0·24	1·3	·00	2·37	0·31	129·2	2·58	1,075
Yearly Total	23·63	73·2	13·85	34·60	3·90	16·5	64·95	275

(2) *The Amount of Rainfall during a Single Precipitation.*—In order to produce any direct effect on the vegetation, a certain minimum amount of rain is required. Cannon (1924) arbitrarily puts the lowest limit of effectiveness at 0·15 inch, and the effective rainfall is derived by substracting the amounts below this figure from the precipitation. Table III shows the relation between non-effective and effective rainfall for Potchefstroom for the 4-year period 1938–41. The mean ratio NE/P of 8·9 per cent. compares favourably with other areas in the Union (Cannon, 1924 : 37). It must, however, be considered that Cannon's effective minimum is an estimate of effectiveness for arid regions in which plants have evolved means of utilising exceedingly small amounts of moisture; in the present area the figure should be rather higher. Furthermore, the minimum amount of rain to benefit the vegetation directly cannot be defined without taking into account such factors as temperature and humidity, and since these are variable, the effective minimum cannot be a constant.

The table also shows a considerable reduction in the number of rain days, if those days on which ineffective showers fell, have been deducted. This reduction amounts to over 40 per cent.

On the other hand, precipitations in excess of two inches per hour have been recorded at Potchefstroom on several occasions (Saunders, l.c.). Heavy rains of comparatively short duration lose much of their effectiveness through run-off. In such circumstances, the amount taken up in the soil will depend largely on the density of the vegetal cover, the gradient of the terrain and the texture of the soil. With the exception of local prominences, the area under review is relatively flat and the soils on the whole of a medium to a coarse texture, particularly in the Dolomite zone, but they are generally bare or sparsely covered, especially during the dry months preceding the recovery of the veld after the first consistent summer rains. The run-off during this period must be considerable.

TABLE III.

ANNUAL PRECIPITATION (P); NON-EFFECTIVE PRECIPITATION (N–E) WITH N–E/P RATIO; RAIN DAYS, EFFECTIVE AND NON-EFFECTIVE, 1938–41.

Year.	P., In.	N-E., In.	Per Cent. N–E/P.	No. of Rain Days.	No. of N–E Rain Days.	No. of E Rain Days.
1938...........	19·78	1·86	9·4	71	30	41
1939...........	28·55	2·01	7·0	77	26	51
1940...........	23·11	2·02	8·7	67	28	39
1941...........	14·96	1·77	11·8	58	27	31
Means for Four Years	21·60	1·92	8·9	68	28	40

(3) *The High Rate of Evaporation*, which is far in excess of the rainfall for any month, is another important factor concerning the loss of the potential benefit from rain. Table II shows a steady rise from the lowest figure in June (2·58 in.) to the highest in November (8·13 in.), after which month it gradually descends. Normally, the last good rains of the season may be expected in March when evaporation is still fairly high. If effective spring showers are then delayed until the following October or November, as frequently happens, when the evaporation soars about the maximum, the condition of grazing and the prospects for crops become very serious. When such conditions prevail, only comparatively heavy and continued showers have any beneficial effect on the vegetation.

TEMPERATURE.

The only temperature records available for the area are those of the Potchefstroom College of Agriculture. This is unfortunate, since there is evidence—which cannot be substantiated by figures—of local variations of temperature due to topographical factors. For instance, many efforts to grow citrus trees in Potchefstroom have failed in spite of all conceivable methods of protection, while citrus orchards at Venterskroon and Losberg, sheltered by relatively high hills, do well without such precautions.

The low winter temperatures along the vleis and rivers as compared with those of higher ground, is common knowledge with the local inhabitants. This is probably due to the phenomenon of cold air drainage. At Welverdiend, for instance, it has been observed that frosts occur along the vlei not only earlier and later in the season than on the neighbouring rises, but they are here also more severe. The effect of temperature on the distribution of the natural vegetation is difficult to estimate by way of comparison, as it is obscured by other factors such as soil-type and soil-moisture.

The northern and southern slopes of ridges trending in an east-westerly direction, often reveal striking differences in the composition of the vegetation. Temperature here evidently plays a predominant rôle, though other factors may not be excluded.

For the purpose of ecological study, records of mean temperatures are relatively unimportant (Dyer, 1937; Bayer, 1938). The extreme temperatures, on the other hand, are the limiting factors, since such records reveal the critical conditions a plant has to endure if it is to survive.

The monthly absolute maximum (AM) and absolute minimum (am) air temperatures and the absolute minimum grass temperatures (Gm) for the five years 1936–40 appear in Table IV. The air temperatures were taken in the standard Stevenson screen, four feet above the ground, and the grass temperatures two inches above the ground surface, covered with short grass. In the table the absolute maximum and absolute minimum temperatures for each year are marked with an asterisk (*) and a dagger (†) respectively, while the grass temperatures below freezing point are underlined. From the table it is evident that the yearly maxima fall in November, December and January, while the minima show a much more irregular distribution and are spread out over five months, viz. from May to September. The most devastating frosts of the year may therefore occur at any time from late autumn to mid-spring. Grass temperatures below freezing point may occur as early as March and as late as November. Late frosts, which are no exception, frequently cause serious damage to winter cereals in the ear and practically rule out fruit production as a farming proposition. It is not uncommon for summer vegetables to miss the early market as the first plantings are not infrequently destroyed by frost. The effects of late frosts are particularly severe if growth has already been stimulated by preceding spells of warm weather.

RELATIVE HUMIDITY, ATMOSPHERIC PRESSURE, WINDS.

Again, the only figures available for the area are those of the College Agriculture at Potchefstroom. These have been dealt with by Saunders (1942) and the following extracts will suffice.

The inverse relationship between atmospheric pressure and rainfall is illustrated in Fig. I. From a peak in July atmospheric pressure descends steadily to its lowest point in January, whereafter it shows a steady rise to June. The moisture content in the atmosphere is lowest in September-October and highest in March-April.

Mean wind velocities remain comparatively constant throughout the year. Nearly 90 per cent. of the wind has a velocity of less than 14 miles per hour. Winds in the north-east to north-west quadrant predominate to the extent of over 40 per cent. of the directional frequency, while less than 10 per cent. prevails in the east to south quadrant.

TABLE IV.

EXTREME TEMPERATURES: POTCHEFSTROOM.

AIR ABSOLUTE MAXIMUM (AM), AIR ABSOLUTE MINIMUM (Am) AND GRASS ABSOLUTE MINIMUM (Gm) TEMPERATURES IN DEGREES FAHRENHEIT.

Year.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1936............	AM	92·5	92·0	87·8	83·8	79·2	72·5	77·8	82·0	86·2	87·0	94·5	95·0*
	Am	41·5	51·5	47·3	39·5	23·5†	23·8	24·5	25·0	30·0	32·0	46·0	49·0
	Gm	42·5	48·5	46·0	37·0	*20·9*	*21·0*	*20·0*	*18·5*	*23·0*	*23·0*	—	41·0
1937............	AM	91·1	87·5	88·1	84·5	85·5	76·0	73·0	80·0	91·0	94·3	96·0*	94·0
	Am	56·0	52·3	37·9	30·0	26·0	16·0†	17·0	22·5	22·7	43·0	45·0	52·0
	Gm	46·5	46·0	*28·0*	*21·0*	*18·0*	*6·0*	—	*11·5*	*10·5*	—	*24·0*	38·0
1938............	AM	94·0	88·0	89·0	87·0	81·5	72·0	75·0	82·0	91·0	91·0	96·0*	89·0
	Am	50·5	45·5	49·0	38·0	29·5	27·0	27·0	27·0	25·5†	37·0	37·5	50·0
	Gm	40·0	36·0	42·0	*31·5*	*24·0*	*22·0*	*21·0*	*17·0*	*15·5*	*25·0*	33·0	45·0
1939............	AM	96·0*	88·0	84·0	82·0	81·0	72·0	73·5	80·0	85·0	91·0	88·0	94·0
	Am	49·0	56·0	41·0	28·0	31·0	26·0	28·5	22·0†	31·0	39·5	44·0	44·0
	Gm	47·0	53·0	36·0	*21·0*	*21·0*	*19·0*	*22·0*	*12·0*	*22·5*	*31·0*	37·0	39·0
1940............	AM	95·0	91·0	86·0	84·0	78·0	76·0	77·5	82·0	89·0	93·5	94·0	96·0*
	Am	49·0	46·0	46·0	32·5	26·5	20·0†	21·5	26·0	36·0	37·0	45·0	55·0
	Gm	34·0	43·0	41·0	*29·0*	*20·0*	*14·0*	*14·0*	*19·0*	32·0	33·0	40·0	46·0

Figures for Tables I and IV were taken from the Meteorological Report, Department of Irrigation; those for Table III were computed from figures kindly supplied by the Meteorological Research Bureau, Pretoria.

CHAPTER III.

THE VEGETATION OF VLEIS AND STREAMS.

Nowhere in the area is the modification of the natural vegetation so evident and the destructive consequences of man's interference so manifest as along the numerous spruits and vleis. This is confirmed by abundant testimony of the older inhabitants. Many a place where but a half-century ago there existed impenetrable bogs and reedswamps, teeming with bird-life and harbouring a rich aquatic fauna such as otters and cane-rats, is to-day marked by a broad, bare, sun-baked valley, often with a gully or donga meandering through it. Changes like these are usually quoted in support of the erroneous belief that the rainfall has diminished in recent times. The basic cause, however, is to be sought, as Fick (1944) has rightly pointed out, in the change or destruction of the vegetal cover, which progressively facilitates run-off as the surface becomes denuded and the gullies are cut. The amount of water entering the deeper soil layers through seepage is correspondingly reduced, the water-table lowered and the springs cease to flow. This directly affects the vegetation in the elimination of the aquatic and helophilus species, which are the most efficient soil binders. The general trend is therefore more and more towards the xerophytic as the interaction between loss of effectiveness of the precipitation on the one hand, and the disappearance of the original flora on the other, is allowed to go on (Figs. 10, 11).

Why this particular vegetation type has suffered so much since the advent of the European farmer, is evident. The first European habitations were established in close proximity to permanent water. The water drill, which made all-the-year-round grazing possible on the " dry " farms, came much later. Farms bordering on a water-front have therefore been subjected to intensive grazing for a much longer period than those without permanent surface water. Moreover, the older farms have been more repeatedly subdivided among the heirs of each succeeding generation, with the result that water-farms to-day are cut up into extremely small portions—often " undivided ", with communal grazing rights—a condition very conducive to overstocking. Permanent drinking places and the fact that green herbage can be obtained when the adjoining veld is still dry, further contribute to the concentration of farming stock on vlei veld. Again, as along the Wonderfontein Loop, the vleis have been drained artificially and the streams diverted into canals for the purpose of irrigation. In such instances, practically no trace of the original flora is left.

Of the springs which used to maintain the vleis and streams throughout the year in comparatively recent times, only a few are still existent. On the other hand, those issuing from the Dolomite formation, have remained remarkably constant. The average daily output over a period of 26 years of the Gerhardminnebron Eye, varied from 12 to 13½ million gallons, while that of the spring at Bank Station is estimated at 12 million gallons (Frommurze in " Geology of Ventersdorp ", 1935).

The early stages of the hydrosere are best revealed near Bank Station and along the upper course of the Mooi River. Here, in spite of the comparatively small volumes discharged from the springs, there are relatively large bodies of water, owing to the low gradient laterally as well as downstream. The beds of these vleis contain a thick layer of black mud with a high humus content. Along the Vaal River, conditions are different in various respects, and its ecology may best be treated separately.

(*a*) THE FLOATING STAGE.

Free-floating hydrophytes are poorly represented. *Riccia fluitans* var. *aquatica* Linn. forms floating balls in clear running water, while algae, of both filamentous and unicellular forms, are typical of shallow, sunny, stagnant pools. An undetermined species of *Utricularia* (LENTIBULARIACEAE) is the only phanerogamic representative in this category.

Submerged plants which are anchored to the substratum are in greater abundance. The most conspicuous of these are the water lilies, *Nymphaea spectabilis* Gilg. (NYMPHAEACEAE), characteristic of the open pools of the Mooi River, and *N. nelsonii* B. Davy, which occurs near Bank Station, its type locality. The large floating leaves of these species often cover the water surface so completely and intercept sunlight so effectually as to preclude the entrance of other submerged species. *Ilysanthes conferta* Hiern. (SCROPHULARIACEAE) is a rare species in this area. It was once found at De Beerskraal, north of Welverdiend, where it formed a pure consociers in a seasonal pan (Fig. 2).

Crassula natans (CRASSULACEAE) exhibits remarkable powers of adaptation to its habitat. At the Gerhardminnebron Eye the typical form occurs, as elsewhere, in permanently boggy situations. The slender rooting stems lie prostrate on the mud and produce erect flowering shoots, 2–4 inches high, with short internodes. In the same locality, however, it also grows as a floating aquatic in clear running water about one foot deep. The stems, up to over 15 inches long and ⅛ inch in diameter, bear much larger leaves throughout their length. The plants are rooted in sand and, but for the apical half-inch or so, are completely submerged. They are kept afloat by virtue of well-developed air-canals in the stems. The solitary axillary flowers are borne on the tips of the branches which project above the water, but by the time that fertilisation has been effected, the stems have lengthened sufficiently to allow the portion of the stem bearing the fertilised flowers to sink below the surface, where the fruits mature. The aerial parts of the plants are green, but take on a reddish colour after they become inundated. This is no doubt due to the development of anthocyanin, a feature typical of many water plants. This pigment, however, is lacking in the marsh form. So unlike are the two forms, that they can easily be mistaken for different species. No intermediate forms were found in that locality.

Other aquatics of the open waters are *Ludwigia palustris* Ell. (ONAGRACEAE) and *Nasturtium officinale* Ait. f. (CRUCIFERAE) though both these are equally at home and usually better represented in shallow water along the edges of the streams. *Potamogeton schweinfurthii* A. Benn (= *A. leucens* var. *fluitans* Coss & Germ.) (POTAMOGETONACEAE) forms large floating masses in the deeper stagnant or slow-moving water, while *P. pectinatus* Linn. and *P. pusillus* Linn. inhabit shallow water along streamsides and in shallow depressions. *Lagarosiphon major* (Ridl.) Moss (HYDROCHARITACEAE), which has become a pest in permanent waters elsewhere, e.g. Zoo Lake, Johannesburg, is not a menace in this area. *L. muscoides* Harv. is rare in the area, but it was once found in a small pond which was completely covered with it.

(*b*) THE REEDSWAMP.

The most conspicuous constituent of the vlei flora is the reedswamp with *Phragmites communis* Trin. (GRAMINEAE), *Typha australis* Schum. & Thonn. (TYPHACEAE) and *Scirpus corymbosus* Roth. (CYPERACEAE) as its almost exclusive members, and from centre to shore, usually arranged in the order given (Fig. 3). It is interesting to note that in the reedswamps of North America (Weaver & Clements, 1929) and of Europe, with the omission of *Typha*, (Arber, 1920) the usual order of these genera is reversed. Although *Phragmites* generally forms the inner zone and *Scirpus* the outer, the three species also occur intermixed, especially in the shallower water. The depth of the water is generally held to account for the zonal distribution of consocies in the hydrosere (*vide* Warming, 1909, p. 145; Clements, 1928, p. 280). While this is no doubt true of the hydrosere as a whole, it often fails to explain the particular distribution of the three species characteristic of the reedswamp. *Phragmites communis* has been observed to flourish in water ranging in depth from a few inches to over three feet; for *Typha australis* and *Scirpus corymbosus* the range is from above the water-surface, on mud, to a depth of three feet and 18 inches respectively. Besides, all three species have been found to occur in dry vleis and spruits which practically never become submerged, except, perhaps, on a few occasions during the rainy season. In these situations, however, they may best be regarded as the vestiges of a former luxuriant vlei flora.

The problems sometimes presented by the seemingly erratic distribution of the different members of the reedswamp are alluring, yet very difficult to explain satisfactorily. Warming (1909) states that in many cases " minor distinctions in the soil " account for the existence of " associations " within the " formation ". This can hardly apply to the reedswamps of this area in which the soil, as indeed all controlling factors, as far as one can judge, appear to be perfectly homogeneous from one consocies to another. Besides, as Clements (1928) has pointed out, dominants are tolerant of a wide range of conditions. For the present, in the absence of experimental knowledge, one feels inclined to endorse Warming's other suggestion (1.c.) that accident seems to decide the question: the species which first colonized the spot will subsequently be able to maintain itself against others. Fig. 1, showing how *Nymphaea* territory is being invaded by *Typha australis*, where *Phragmites communis* would have been the normal successor, seems to lend support to this view. Permanent quadrat studies and sod transplants will no doubt reveal to what extent each species is able to maintain itself.

All three species are vigorous growers which extend their area of occupation by means of rhizomes, a universally common feature among hydrophytes. In addition, vivipary as a mode of invading open water, is commonly adopted by *Scirpus corymbosus* (Fig. 4). Young plants are produced from seeds which germinate in the terminal inflorescences of the outer stems of a clump, and owing to their increasing weight, the stems bend down and come to rest on the water surface. As the young plants develop, a cluster of roots is sent downwards and eventually strikes the muddy bed. By the time these plants become established, the old stem has died and connection with the parent plant is severed. This appears to be a highly successful manner of migration, since—and this also applies to the rhizome method—ecesis is effected without subjecting the younger generation to the perils which normally follow upon germination. It may be noted too that the viviparous habit has not been observed in plants of this species growing on land, which tends to indicate that this phenomenon is induced by a relatively high humidity.

It may be noted in passing that the rôle played by these plants in the raising of the floor by trapping moving material, is very apparent in clear water as at Bank Station, where they appear to be growing on mounds.

Closed consocies of *Cladium mariscus* R. Br. (CYPERACEAE), but of limited extent, are not infrequent in the reedswamp. It is difficult to conceive why this vigorous grower, up to over six feet tall, is not better represented in the vleis.

(*c*) THE VEGETATION OF STREAMSIDES, MARSHES AND PERIODICALLY FLOODED SITUATIONS.

The next stage in the hydrosere is represented by a rich assemblage of species growing on moist or saturated soil or in shallow water and muddy pools on the outer flank of the reedswamp and in vleis where the reedswamp is lacking. The conditions prevailing in the shallow, stagnant water differ in some important respects from those obtaining in deeper water. Thermal fluctuations are more pronounced and the oxygen-content is lower. Where farm animals have access, extensive damage to the vegetation is usually done through trampling. This also modifies the soil structure and in severe cases the mud is kept in a constantly puddled condition.

Since the majority of species multiply by means of rhizomes or stolons, or produce roots from the nodes of prostrate stems, there is a marked tendency towards aggregation of individuals of the same species. In general, this community is constituted of a mixture of consocies rather than of a mixture of different individuals.

The species equipped for or adapted to the foregoing extreme conditions, i.e. where water prevails in excess, are relatively few. As the succession advances and the habitat becomes more moderate, a great multitude of species, not so highly specialised, appear on the scene. Many of the species exhibit a remarkably wide range in their water requirements. Bews (1925) and Schönland (1922) have stressed the fact that South Africa is particularly rich in species of Cyperaceae which grow in localities that are subject to periodic intense drought. This applies equally well to species belonging to a number of other families. Arber (1920) points out that the majority of water plants, with the exception of those most highly specialised for aquatic life, are capable of giving rise to land forms. Prolonged droughts make a strong demand for adaptability to varying water supply. Vleis and " pans " (local depressions) may be inundated for considerable periods, to be followed by long spells of severe drought, and most of the vlei species respond effectively to this alternation of wetness and dryness. There therefore exists no clear distinction between marsh and terrestrial plants in the vlei flora, though some may show a distinct preference for aquatic life.

The following are the most important representatives, the phanerogamic families being arranged according to Phillips : " Genera of South African Flowering Plants ":—

MARSILIACEAE: *Marsilia macrocarpa* Presl. is a common aquatic in shallow depressions, muddy pools and in slow-running streams where, owing to its wide-creeping rhizomes, it forms consocies of considerable extent. It seems to favour open situations, but also occurs in shady spots, in which case the petioles extend to a greater height above the water-surface. It is able to survive long periods of drought.

EQUISETACEAE: *Equisetum ramossimum* Desf., a very variable plant as regards vegetative characters, forms occasional stands on streambanks. It appears to be indifferent to soil type, for it occurs on the sandy banks and islands of the Vaal River as well as on heavy black clay along the Mooi River.

Monocotyledons.

POTAMOGETONACEAE: *Potamogeton pectinatus* Linn. and *P. pusillus* Linn. are common in stagnant or slow-moving water a few inches deep, and they frequently form associes with *Marsilia macrocarpa.*

Aponogeton spathaceum E. Mey., the only representative of the APONOGETONACEAE, appears to be fairly localised in its distribution, but is abundant on low-lying flat ground on the outskirts of Potchefstroom. It grows on black clayey soil which is usually flooded during the rainy season. Though the individual inflorescences are rather humble-looking, they produce a striking mass-effect in their natural surroundings.

GRAMINEAE: With the sedges, this family forms the bulk of the vlei vegetation. It comprises 26 genera and some 40 species as against 11 genera and 30 species for the latter family, in each case excluding those species which, despite their possible presence, do not show a distinct preference for the vlei habitat. Some of the grasses are distinctly hygrophilous, while the remaining species exhibit the amphibious habit in varying degree.

Leersia hexandra Sw., with its creeping rhizomes, is very common and often co-dominant with such plants as *Potamogeton pusillus*, *Marsilia macrocarpa* and *Paspalum distichum* Linn. in shallow pools and on streambanks. The last-named species generally forms a short, dense cover in such localities, but it also migrates into deeper water from its stronghold on the banks as at the Vaal River. In such events, its robustness increases with the depth of the water and it behaves as a floating aquatic. The genus *Echinochloa* is most frequently represented by the erect, 2–3-foot high *E. holubii* Stapf which occasionally forms dense, closed consocies along the edges of the Vaal River and in spruits, and the decumbent *E. stagnina* Beauv., of which isolated individuals often occur on marshy ground. *Hemarthria altissima* Stapf & Hubb. with its long, prostrate, rooting stems forms dense mats on moist streambanks. In muddy depressions, which retain water for some time during the rainy season, *Imperata cylindrica* var. *thunbergi* D. & S. forms closed stands of varying extent. *Miscanthidium junceum* Stapf, a tall grass over five feet high, occurs as isolated tufts on the moist, sandy banks of the Vaal River, but has not been observed elsewhere in the area. Another tall-growing species, *Arundinella ecklonii* Nees, is rather rare. *Eragrostis namaquensis* Nees var. *robusta* Stapf occurs on moist sand of the Vaal River islands. *Diplachne fusca* Beauv., though rare, forms closed consocies in periodically flooded depressions.

The following species, though typical of moist situations such as low-lying ground, banks of irrigation canals and water-furrows, show no special aptitude for aquatic life. In vleis in which the complete hydrarch succession is presented, they occur on the outer fringes, but in " dry vleis " and along ephemeral streams and spruits they may be encountered in any part. *Agrostis lachnantha* Nees is common and often dominant, while the Hyparrhenias, particularly *H. hirta* Stapf, often cover large stretches in the wide valleys of some spruits and other low-lying ground. *Andropogon eucomus*

Nees is the only gregarious species of the genus in the area and frequently forms small consocies. *Setaria pallidifusca* Stapf & Hubb. and *Digitaria ternata* Stapf sometimes become weeds in vlei lands under cultivation, as do the aliens *Bromus catharticus* Vahl and *Lolium multiflorum* Lam. *Paspalum dilatatum* Poir., another alien, has become completely naturalised in moist localities. Other vlei grasses, though they do not attain local dominance, but are nevertheless frequently met with, are *Andropogon appendiculatus* Nees, *Panicum coloratum* Linn., *Brachiaria isachne* Stapf, *Pennisetum thunbergii* Kth., *Sporobolus fimbriatus* Nees., *S. pyramidalis* Beauv., *Helictotrichon* (= *Avenastrum*) *turgidulum* (Stapf) Schweick., *Eragrostis curvula* Nees, *E. nebulosa* Stapf, *E. plana* Nees and other *Eragrostis* spp., *Hordeum nodosum* Linn.

CYPERACEAE: The majority of the species belonging to this family are hygrophilous in a greater or lesser degree, and form the most important constituent of the vegetation fringing the reedswamp. Most of the sedges in this community exhibit a marked degree of plasticity and may be encountered in aquatic, helophytic and mesophytic habitats, though the optimum range probably varies from one species to another. With the exception of the annuals and a few others, the rhizomatous habit is common to all. They therefore form very closed associes and are excellent soil binders.

The genus *Cyperus* is best represented both by species and individuals, though *Scirpus* also ranks high in prominence. The taller species of *Cyperus* are characteristic of the more aquatic situations. *C. distans* Linn. f., *C. haematocephalus* C.B. Cl., *C. fastigiatus* Rottb. and *C. longus* var. *tenuiflorus* Boeck. are common along the edges of streams and in marshy localities; also the annual *C. difformis* Linn., which may vary in height from about 3 inches to over 1½ feet. *C. marginatus* Thunb. is another robust species which plays a major rôle in the succession in the Vaal River, but is relatively unimportant elsewhere.

Scirpus corymbosus Roth., which figures so prominently in the reedswamp, is often also one of the most conspicuous species in situations which are not permamently inundated. *S. setaceus* Linn., a small annual, is sometimes very common in shady places.

The genus *Pycreus* is well represented in marshy localities by *P. lanceus* Turrill, while *P. mundtii* Nees frequently invades open water from the bank by forming floating mats. *Eleocharis palustris* R.Br., *Carex vulpina* Linn. and *C. clavata* Thunb. are fairly common. *Fuirena pubescens* Kunth and *F. gracilis* Kunth usually form pure consocies. *Rhynchospora glauca* Vahl. has been recorded in this area only from Elandsfontein. Scattered individuals of *Kyllinga erecta* Schumach., *Mariscus congestus* C.B.Cl. and *M. rehmannianus* C.B.Cl. are common throughout. *Scirpus dioecus* Boeck. and *S. burkei* C.B.Cl. usually occur in considerably drier parts.

ARACEAE: *Zantedeschia aethiopica* Spreng., the white Arum lily, which according to local inhabitants used to be common along the banks of the Mooi River in the past, has disappeared almost completety. It still occurs at Elandsfontein, but here too, the numbers are much reduced.

LILIACEAE: The orange masses of *Kniphofia rivularis* Berg. occasionally brighten up the mixed sedge associes along the low-lying slopes of the Mooi River, where *Notosceptrum natalense* Bkr. also occurs (Fig. 9).

Tulbaghia alliacea Linn. (Amaryllidaceae) and *Scilla cooperi* Hook. are small bulbous plants which grow more or less gregariously on open, moist ground.

AMARYLLIDACEAE: The bright red-flowered *Haemanthus magnificus* Herb. is very common under trees in some localities on the slopes above the Vaal River; the white-flowered *H. amarylloides* Jacq. frequently occurs in open, dry vleis, as does *Ammocharis coranica* Herb. *Crinum* sp. is common along the Mooi and Vaal Rivers.

IRIDACEAE: This family is represented by the "tulps", of which the blue *Moraea trita* N.E.Br. var. *foliata* N.E. Br., *Helixra simulans* N.E. Br. and the yellow *Homeria pura* N.E.Br. are the most frequent. The latter sometimes forms fairly extensive consocies.

Dicotyledons.

SALICACEAE : *Salix capensis* Thunb. and the alien *S. babylonica* Linn. are two riparian trees, both very common on the banks and islands of the Vaal River, while only the latter is represented along the Mooi River.

POLYGONACEAE: The genera *Polygonum* and *Rumex* are represented by a considerable number of amphibious species, though they seldom, except in the case of *Polygonum lapathifolium* Dyer & Trin., attain local dominance. *Rumex ecklonianus* Meisn. is common; *R. sagittatus* Thunb., a vigorous scrambler, sometimes covers small trees completely.

RANUNCULACEAE: *Ranunculus pubescens* Thunb. is very common along water-courses and in moist depressions. On low-lying ground it readily becomes dominant if protection against animals is given (Fig. 7). *R. meyeri* Harv. is much rarer and confined to marshy places.

CRUCIFERAE: *Rorippa caledonica* (Sond.) R. A. Dyer and *R. fluviatilis* (E. Mey.) R. A. Dyer are frequent in wet situations, but do not, as a rule, form closed stands. *Nasturtium officinale* Ait. f., on the other hand, is usually massed together and common along the egdes of permanent streams.

ROSACEAE: The bramble, *Rubus rigidus* Sm. var. *mundii* Harv. frequently occurs on moist, sandy soils of mountain streams. *Agrimonia eupatoria* var. *capensis* Harv. is widely distributed and is inclined to become a weed in vlei land under cultivation.

LEGUMINOSAE: Papilionaceae: Surprisingly few species of this large family are represented in the vlei flora, and those which do occur, are often very localised in their distribution. *Trifolium africanum* Ser. and *T. repens* Linn. are fairly common on low-lying ground along the Mooi River. The annual *Sesbania mossambicensis* Kl. grows gregariously in dry vleis and spruits, and sometimes acts as a pioneer in disturbed areas. Dense consocies are occasionally formed by the tall *Astragalus burkeanus* Benth. Scattered plants of *Erythrina zeyheri* Harv. with its blood-red flowers are a frequent occurrence on the higher slopes of vleis. *Eriosema salignum* E. Mey. and *E. polystachyum* (A. Rich.) Bak. are rather rare and occur on moist, sandy soils.

EUPHORBIACEAE: *Euphorbia striata* Thunb. is widely distributed, while *E. peplus* Linn. is very common along water-furrows and in gardens in Potchefstroom.

Hypericum lalandii Choisy of the GUTTIFERAE is common in some localities of the eastern portion of the area.

ONAGRACEAE: *Ludwigia palustris* Ell. is widely distributed and common in boggy situations, though it also behaves as a floating aquatic. *Epilobium hirsutus* Linn. is frequent along the Mooi River. The alien genus *Oenothera* has become completely naturalised and is well represented by *O. rosea* Ait. and the nocturnal *O. tetraptera* Cav. *O. jamesii* Torr.& Gray, a tall-growing erect annual with conspicuous yellow flowers, is common on streambanks and water-furrows of the Wonderfontein Loop. *O. odorata* Linn. is rarer.

HALORRHAGIDACEAE: This family has only one representative in the present category, *Gunnera perpensa* Linn., and at Elandsfontein it forms a major constituent of the vlei vegetation. It is of anatomical interest in being polystelic. [Bews (1925, p. 117) and Arber (1920, pp. 180 foll.) give a résumé of the hypotheses put forward to explain this interesting phenomenon].

UMBELLIFERAE : A considerable number of genera are represented and the individuals of the various species often enjoy numerical importance. *Berula thunbergii* (DC.) Wolff (= *Sium thunbergii* DC.) is very common along water-furrows and the margins of vleis. *Hydrocotyle verticillata* Thunb. often forms extensive undergrowth in marshy places, but its near relative, *Centella asiatica* Linn., is much rarer. *Apium leptophyllum* Muell. is common. The wild parsnip, *Pastinaca sativa* Linn., is a garden escape, and has been recorded at Gerhardminnebron in swampy vlei land—where it still is common—as early as 1907 (B. Davy, 1932). Other species frequently met with are *Ammi majus* var. *glacifolius* Noul., *Foeniculum vulgare* Miller and *Daucus carota* Linn.

ERICACEAE: *Erica alopecurus* Harv., which occurs at the side of a perennial stream at Elandsfontein, is the only representative of this family in this area. It is listed here, not on account of its abundance, but because of the interesting distribution record.

Buddleja salvifolia Lam. (LOGANIACEAE) is well represented along the perennial streams of rocky kloofs, as at Elandsfontein and Losberg, but absent from vleis.

The ASCLEPIADACEAE have a few important members. *Xysmalobium undulatum* R. Br. (Fig. 8), *Cordylogyne globosa* E. Mey. and *Asclepias meyeriana* Schltr. are frequent on clayey vlei soils. The twiners, *Cynanchum virens* Dietr. and *Riocreuxia polyantha* Schltr., occur along streambanks in certain localities, while the shrub, *Asclepias rivularis* Schltr., with its long, flexible branches, is a frequent inhabitant of running water such as irrigation canals. Its smooth inflated fruits are eminently suited to water dispersal.

CONVOLVULACEAE: *Falkia oblonga* Bernh. (Fig. 6) forms dense, often extensive mats on bare areas on the higher slopes of dry vleis. It makes a pretty sight in spring owing to its floriferous habit, and it may be well worth investigating its possibilities as a lawn plant. It has a compact rhizome system, is very hardy, and if it behaves in cultivation as it does in nature, would require no mowing. *Seddera capensis* Bkr. and *Convolvulus liniformis* Rendle grow in similar situations, but are much less prominent. The parasitic weed, *Cuscuta campestris* Yunck., favours moist situations such as low-lying ground and streambanks, where it parasitises a great variety of hosts.

The VERBENACEAE are represented by *Verbena bonariensis* Linn and *V. officinale* Linn., both of which are confined chiefly to water-furrows, riverbanks, etc.

LABIATAE: *Stachys hyssopoides* Burch. & Benth. is often very common, though it fails to establish pure consocies. *Salvia stenophylla* Burch. and *S. runcinata* Linn. are common in dry vleis, while *Mentha* spp. are limited to permanently wet situations.

SCROPHULARIACEAE: *Limosella major* Diels, an aquatic species, often forms extensive masses in shallow water. On moist soils *Diclis reptans* Benth., *Sutera aurantiaca* Hiern., the parasitic *Alectra melampyroides* Benth. (= *Melasma sessiliflorum* Hiern.), *Rhamphicarpa tubulosa* Benth. and the polymorphic *Limosella longiflora* O. Ktze. are common, the last-named being particularly well represented along the Vaal River. The cosmopolitan *Veronica anagallis* Linn. is abundant on streambanks and in running water. In seasonal vleis *Mimulus gracilis* R. Br. and *Sopubia cana* Harv. sometimes become dominant in summer.

Pterodiscus speciosus Hook. (PEDALIACEAE) is frequent in bare, dry vleis. The genus *Plantago* (PLANTAGINACEAE) is represented by *P. dregeana* Presl., *P. major* Linn. and *P. lanceolata* Linn., though the last-named also enters grassveld. The large family RUBIACEAE has only *Galium capense* Thunb. in the present community. The most important species of the CAMPANULACEAE are *Wahlenbergia undulata* DC. and *Lobelia decipiens* Sond. (Lobeliaceae), both of which occur as undergrowth in vleis, and the creeping *L. leptocarpa* Griessel and *Mezleria depressa* (Linn. f.) Presl. more common on bare, moist soils.

COMPOSITAE: Despite the many species of this family which show affinity for or are confined to moist conditions, none are encountered in the early stages of the Hydrosere. A fair number occur in the " sedge-meadow " stage, but the majority show preference for the higher vlei slopes and depressions which do not become water-logged for any length of time. In the moister situations, such as streambanks, the following may appear: *Aster subulatus* Michx., *Adenostemma* caffrum DC., *Conyza ivaefolia* Less., *Schistostephium heptalobium* B. & H., *Cineraria lyrata* DC. and *Venidium microcephalum* DC., though some of these show a wide range in their water requirements. *Denekia capensis* Thunb. and *Cenia microglossa* DC. are small plants which form consocies on bare areas in vleis. *Senecio sceleratus* Schweik., *S. serratuloides* DC. and *S. fraudulentus* Phill. & Sm., though their individuals may be outnumbered by other species, often attain physiognomical dominance on the outer margins of vleis by reason of their height and their corymbs of yellow flowers. On the drier grassy slopes *Helichrysum latifolium* Less., *H. nudifolium* Less. var. *leipodium* (DC.) Moeser, *Berkheya stobaeoides* Harv. and *Haplocarpha scaposa* Harv. sometimes become prominent. *Conyza podocephala* DC. is sometimes very evident; it also occurs as undergrowth in Thorn Veld. Many alien weeds which enter vleis and streambanks, e.g. *Cirsium vulgare* (Savi) Airy Shaw, belong to this family.

(*d*) The Vaal River.

When the Vaal River flora is compared with that of the Mooi River and the perennial vleis, the general physiognomy is so different that even the casual observer cannot fail to notice it. A comparison of the two sets of ecological conditions shows the differences to be mainly edaphic. The vlei soil is a deep, heavy, black alluvium, with a high humus content, but poorly aerated. The deficiency of soil air is no doubt mainly responsible for the marked absence of trees whose roots penetrate to deeper levels than do the roots of the vlei species. *Salix babylonica* Linn. and *Populus canescens* Sm. (both exotic) have relatively superficial root systems and are the only trees which flourish in heavy clay. The streams are confined more or less to the centre of a wide valley, sloping very gradually on either side. As a result of this, and since the catchment area is relatively small, the fluctuation of the water level is very slight. In most parts the movement of the water is slow, sometimes almost imperceptible. Decaying vegetable matter therefore readily accumulates on the bed; the water is particularly clear and light penetrates to the floor with a minimum of loss.

The Vaal River, on the other hand, is a fast-flowing stream, often with steep banks on the outer side of the bends. It drains a large area and is consequently liable to be flooded repeatedly during the rainy season. The mechanical disturbance of the vegetation is often considerable, as is evidenced by the large number of trees leaning over at a sharp angle or completely uprooted. Erosion and deposition are continually in progress, abruptly terminating succession in one place and initiating fresh seres in another. The water is of a dirty-grey colour throughout the year, owing to a high proportion of particles in suspension. The amount of light sufficient for photosynthetic functions is therefore probably limited to the upper inch or so. The bed and banks are either stony or composed of a light sandy soil which is derived chiefly from Witwatersrand quartzites.

Whereas the chief limiting factor in the perennial vleis therefore appears to be a deficiency of soil air owing to the compactness of the clay, along the Vaal River it is repeated inundation and the mechanical force of the fast-flowing currents. The main differences in the vegetation of the two habitat types, can be summarised as follows:—

	Mooi River and Perennial Vleis.	Vaal River.
Trees.............	Absent, except *Salix babylonica*, *Populus canescens* along the Mooi River and an occasional stunted tree of *Acacia karroo*, *A. stolonifera* or *Rhus pyroides*	Luxurient tree growth; *Salix capensis* and *Acacia karroo* dominant.
Nymphaea spp......	In open, quiet pools, often covering considerable areas	Absent.
Phragmites communis	Regular dominant of inner zone...	Occasional consocies.
Typha australis......	Regular dominant of intermediate zone	Absent or negligible.
Scirpus corymbosus..	Regular dominant of outer zone...	Practically absent.
Cyperus marginatus..	Rare and insignificant............	Chief pioneer in shallow running water.

Excellent opportunity to study the ecology of the Vaal River is presented at the farm Nooitgedacht which borders on that river. The different variations in habitat which occur in and along the river (within the limits of the present area) are represented here within a relatively small area, and the vegetation peculiar to each of these is very typical of that occurring in similar situations elsewhere along the river; moreover, interference of man and his animals is negligible. The river bed is broad, bounded along the east bank by a quartzite ridge of the Kimberley-Elsburg series, and on the west by a broadly rounded ridge of Ventersdorp lavas. The river bed is strewn with numerous islands between which the streams of varying size and velocity fork and anastomose irregularly (Fig. 13). The islands, varying greatly in size and height above the normal water level, range from a few yards long and almost flush with the water surface to about a half-mile long and up to over 30 feet high. At times of flood, most of the smaller islands are submerged, banks are cut away and sand, often with coarser material, deposited elsewhere in the bed. Very diverse habitats are present and a complex of factors is involved. The substratum varies from sandy soil to rock. The oxygen content and mechanical strain which vary directly with the velocity of the stream, occur in varying degree, from boggy places and stagnant pools to strong currents over rapids. Deposition of water-borne material results in more or less complete obliteration of the existing herbaceous vegetation and the initiation of a psammosere. The following types of habitat can be distinguished:—

(i) In fast-flowing streams and particularly on the smaller islets, *Cyperus marginatus* Thunb. forms the dominant and often the only vegetation. It forms a very dense and continuous cover which readily intercepts floating debris and tends to slow down the speed of the current, causing it to release its load of sand. Thus the island is gradually built up. When partly or completely covered by sand, *C. marginatus* grows less luxuriantly or disappears altogether. Other species of the Cyperaceae, among which *C. longus* var. *tenuifolius* Boeck. appears to be the most important, occupy the higher ground thus formed. Soon *Oenothera rosea* Ait., *Aster subulatus* Michx., hygrophilous grasses, *Asclepias fruticosa* Linn. and seedlings of *Salix capensis* Thunb. make their appearance.

Gomphostigma virgatum (Linn. f.) Baill., a woody aquatic, is common in rapids and wherever the bed is stony. Its roots are firmly wedged in crevices in the rock.

(ii) Filamentous algae, *Potamogeton schweinfurthii* A. Benn., *P. pectinatus* Linn. and *P. crispus* Linn. are characteristic of slow-moving currents. According to local inhabitants, the Potamogetons have increased with great rapidity since the completion of the Vaalbank Dam above Vereeniging in 1938. Prior to that year, the Vaal River maintained a constant flow only during the rainy season and these plants were then comparatively rare. *Myriophyllum spicatum* Linn. (HALORRHAGIDACEAE) has not been found at Nooitgedacht, but occurs elsewhere in the river. *Leersia hexandra* Sw., *Paspalum distichum* Linn., *Phragmites communis* Trin. and *Polygonum amphibium* Linn. are also common.

(iii) Shallow, stagnant pools which are formed by water oozing in from below, when the bottom of a depression is lower than the water table, occur on several islands. Algae and *Juncus exsertus* (JUNCACEAE) are the most prominent. *Alisma plantago* Linn. (ALISMATACEAE), which occurs in abundance in some of these pools, is an interesting distribution record. It is a Mediterranean species, but extends southwards to Tropical Africa, and as far as could be ascertained, has never before been recorded in this country.

Jussieua diffusa Forsk. (ONAGRACEAE) is remarkable for its ability to produce aerenchyma in lieu of cork in the absence of oxygen (Arber, 1920, 188–9). When the prostrate shoots are covered by mud or water, erect air roots, which apparently serve entirely for aeration, are produced (Fig. 5). The presence of a buried shoot is sometimes revealed only by clusters of white aerial roots lined in a row. These aerating organs, however, are lacking on shoots which leave the pool for higher ground.

(iv) The occupation of freshly deposited sandbars appears to be accidental and erratic, and pioneers especially fitted for that rôle, are absent. *Corrigiola litoralis* Linn. (CARYOPHYLLACEAE), *Argemone mexicana* Linn. (PAPAVERACEAE) and *Asclepias fruticosa* Linn. (ASCLEPIADACEAE) are among the earliest entrants, while Cyperaceae invade from the water's edge.

(v) The streambanks are characterised by *Salix capensis* Thunb., a very ornamental tree with a deeply furrowed grey bark and a dense, glaucus foliage (Figs. 14, 15). By reason of its proximity to water, it is more liable to suffer at times of high flood than other trees. It is not unusual to find a group of *S. capensis* leaning over at a low angle, or prone on the surface of the ground in the direction of the stream. This disadvantage is, however, compensated for by the facility with which these trees strike root wherever the stem makes contact with the soil. Growth is continued and new, erect shoots sprout from the old trunk. Other riparian trees which grow along the Vaal River, at or near the water's edge, are *Salix babylonica* Linn. and *Populus canescens* Sm., though they are much rarer, and neither occur at Nooitgedacht.

The herbaceous cover on the streambanks comprises many species, most of which occur in similar situations in vleis and have already been dealt with. A notable exception is *Ornithogalum zeyheri* Bkr., which is much in evidence along the Vaal River, especially in moist, stony places.

(vi) Higher ground on the larger islands and flood terrace is thickly or sparsely wooded. On the islands the growth is more vigorous and sometimes a continuous canopy is formed. The dominant tree is *Acacia karroo* which here has a well-defined trunk and grows to over 30 feet high, in contrast with its small stature and shrubby appearance on the grassveld flats. Other trees which mix freely are *Zizyphus mucronata* Willd. (RHAMNACEAE) and *Rhus pyroides* Burch. (ANACARDIACEAE). Less frequent are *Royena pallens* Thunb. (EBENACEAE), *Gymnosporia buxifolia* (Linn.) Szysz. (CELASTRACEAE), *Celtis kraussiana* Bernh. (ULMACEAE), *Ehretia rigida* (Thunb.) Druce (BORRAGINACEAE) and *Buddleia salicifolia* Jacq. (= *Chilianthus arboreus* DC.) (LOGANIACEAE). *Grewia occidentalis* (TILIACEAE) occurs frequently as undergrowth. The commonest climbers are *Riocreuxia polyantha* Schltr. (ASCLEPIADACEAE) and *Clematis brachiata* Thunb. (RANUNCULACEAE); *Coccinia sessilifolia* (Sond.) Cogn. (CUCURBITACEAE) is rarer. A number of grasses occur in great abundance as undergrowth or in intervening spaces. *Digitaria eriantha* Steud., valued highly for its feeding qualities, is often dominant on the sandy soils along the river, but soon disappears as a result of uncontrolled grazing. *Ehrharta panicea* Sm. (= *E. erecta* Lam.) and *Panicum coloratum* Linn. are often dominant.

Chapter IV.

THE VEGETATION OF HILLS AND RIDGES.

The hills and ridges of the area are composed mainly of quartzites which show an acid reaction. They nowhere assume the magnitude of mountains, except perhaps in the vicinity of Venterskroon. Differences in altitude in the area may therefore be ignored as a factor in plant distribution. Slope, as a rule, is moderate and a vertical drop of more than a few feet, a rare occurrence.

Perennial streams issuing from the upper slopes, as at Elandsfontein and Losberg, are small and the exceptions, and the prevailing conditions on the ridges are nearly always more xerophytic than the surrounding plains, owing to rapid run-off.

The effect of slope and exposure on plant distribution is generally evident, since the northern slopes receive a much higher total amount of insolation than those facing south. Bews (1925) has shown that a surface sloping north at an angle of 30 degrees with the horizontal has an increased amount of insolation equivalent to a shift of 15 degrees latitude northward. A number of trees and shrubs of tropical-subtropical origin, for instance, occur mainly or exclusively on the northern slopes, e.g. *Pappea capensis* var. *radlkoferi* Schinz, *Combretum holosericeum* Sond. and *Maerua triphylla* (Thunb.) Dur. & Schinz, while the southern slopes are usually occupied by *Protea caffra* Meisn., a representative of the temperate element.

The disintegration of rock is well advanced on practically all the hills and ridges of the area and bare rock of any considerable size or extent is exceptional. Rock on the slopes is usually broken up into stones and boulders of varying size, with the intervening hollows filled with a mixture of finer stone and soil. On the peaks and crests, however, larger masses of solid rock are sometimes exposed, since the products of disintegration are continually being transported towards the lower slopes by wind, water and gravity. There is thus a gradual transition from the extremely xerophytic habitats, such as exist on the exposed rocks on the crests, towards the more mesophytic plains below. This is clearly reflected in the distribution of the plant communities which assume a more or less horizontal zonal arrangement. Proceeding downwards from the top of a typical hill or ridge, the various communities are arranged in the following order. The earliest pioneers as represented by lichens, mosses and *Selaginella*, inhabit the exposed rock on the top. This stage, however, is rarely present. Next comes what may be termed the chasmophytic stage, characterised by a mixture of trees, shrubs and herbs, rooted in the rock crevices. *Acacia caffra* Willd., with a mixture of tufted mountain grasses, usually occupy the lower slopes, and finally *Acacia karroo* Hayne spreads out on the plain below. In the order given, these communities represent the successive stages in the xerosere.

This zonation is not always very evident and is not so sharply defined as in the hydrosere, nor do all the hills and ridges exhibit the complete series of stages. Some hillslopes are almost or quite treeless, or especially on the broadly rounded hills, where rock is not exposed on the surface, the succession has advanced beyond the cryptogamic and chasmophytic stages.

The first invaders of bare rock are crustose lichens, such as the brick-coloured *Caloplaca cinnabarina* (Ack.) Zahl., *Buellia stellulata* (Tayl.) Mudd., *B. halonica* Tuck. and other *Buellia* spp. Foliose lichens, which normally represent the next stage, are very rare and normally absent, a species of *Physica* being the only one observed. The moss, *Bryum argentium* Linn. var. *lanatum* B. & S., is better represented than the latter and usually follows directly upon the crustose lichens.

The duration of the preceding stages is long and the reactions produced by the earliest colonisers very slight. The succession is, however, much accelerated by the entrance of *Selaginella rupestris* (Linn.) Spring. The prostrate stems of this plant branch and rebranch repeatedly, forming a dense cover on the rock; it rapidly collects sand and other detritus and, together with its capacity for retaining water, forms a suitable substratum for various phanerogamic species. The early invaders of this group are characterised by their superficial but extensively ramified root systems, which enable them to utilise very small amounts of mositure. The Monocotyledons furnish most of these pioneers. Among the CYPERACEAE *Cyperus rupestris* Kunth, *C. parvinux* C.B. Cl. and *Coleochloa rehmanniana* Gilly are the most important, while *Lepturella capensis* Stapf is typical of the grasses. The " resurrection plant ", *Myrothamnus flabellifolia* (Sond.) Welw., which occurs on horizontally bedded sandstone, can be lifted with ease with its entire matted root system intact, which may be a square yard or more in extent, but not more than one or a few inches deep.

At this stage *Selaginella rupestris* usually still persists, since direct sunlight seems to be essential to its existence, and the shade cast by most of the foregoing species is very slight. A number of new invaders, however, are now ready to take possession. *Aristida canescens* Henr., *A. spectabilis* Hack., *A. congesta* R. & S., *A. barbicollis* Trin. & Rupr. and *Eragrostis* spp. are among the most important grasses, while a number of ruderals may also enter, e.g. *Schkuhria bonariensis* H. & A. and *Bidens pilosa* Linn. *Hyparrhenia hirta* (Linn.) Stapf, a very plastic species, is not infrequently encountered here.

Where sand accumulates in shallow hollows in horizontally disposed rock, the cryptogamic stage is omitted and phanerogamic species enter direct. *Anacampseros filamentosa* Sims, *Portulaca quadrifida* Linn. and *P. kermesina* N.E. Br. (all of the PORTULACACEAE) are typical of such situations.

The foregoing is an account of the succession on rock fully exposed to the sun and uninterrupted in its continuity. As stated earlier in this chapter, this type of habitat is poorly represented in the area under review, and the evidence regarding the succession in many cases fragmentary. Quite a different sequence is encountered when chasmophytic plants are the early pioneers in the lithosere, as is almost invariably the case in this area. Hard rock like quartzite is liable to split and crack as a result of differential expansion and contraction, and the cracks and crevices so formed, soon collect sufficient detritus and water to provide suitable conditions for the germination of various germules.

Of the smaller shrubs and herbs the following are among the earliest entrants. *Rhus magalismontana* Sond. (ANACARDIACEAE), a small shrublet, only a few inches high and multiplying by means of woody rhizomes, is very common. *R. eckloniana* Sond. varies from one to several feet in height and is remarkable in having some individuals which are distinctly hysteranthous, while others produce flowers only after the leaves have appeared. *Adromischus umbraticolus* C.A.Sm. (CRASSULACEAE) (Fig. 17) grows in the crevices of fully exposed rock, but is also tolerant of rather dense shade; in the latter case, the reddish markings on the succulent leaves tend to disappear. *Aloe davyana* Schönl. (LILIACEAE) frequently acts as a chasmophytic pioneer (Fig. 16). *Aristida spectabilis* Hack. is a very common grass (Fig. 16), though other *Aristida* spp. also occur. Of the Papilionaceae (LEGUMINOSAE) the following are represented: *Lotononis hirsuta* Schinz, *L. foliosa* Bolus, *Pearsonia sessilifolia* Düm. var. *conrathii* Düm., *Tephrosia longipes* var. *uncinata* Harv., *T. elongata* E. Mey., *Rhynchosia confusa* B. Davy. and *R. totta* (Thunb.) DC. *Indigofera comosa* N.E.Br. is a gregarious woody plant about two feet high.

The various trees and shrubs, practically all of which are confined to this particular kind of habitat, not only constitute the most prominent element of the lithosere, but produce far-reaching effects on the habitat itself. Their direct reactions are threefold: (1) The pressure exerted by the growing roots tends to widen the crevices and eventually to split up the rock into smaller and smaller boulders, thus accelerating the invasion of grasses and other herbs. (2) In consequence of the shade produced, the rigorous summer temperatures are reduced, evaporation is retarded and humidity increased. This general ameliorating effect favours the entrance of a shade-loving population. (3) With few exceptions, these trees are all deciduous. This ensures an annual crop of leaves which eventually comes to rest in the numerous cavities and crevices in the rocks, subsequently to be converted into humus.

The following are the most representative of the larger shrubs and trees which are typical chasmophytes: *Lachnopylis montana* C.A. Sm. (LOGANIACEAE) is a low, much-branched shrub or small tree. In the RUBIACEAE are *Vangueria infausta* Burch. and *Tapiphyllum parvifolium* (Sond.) Robyns, both of which bear edible fruits, and *Pavetta zeyheri* Sond. which in spring is covered with white, sweet-scented flowers. *Dombeya rotundifolia* (Hochst.) Harv. (STERCULIACEAE) which is one of the first trees to flower in spring, makes a pretty sight in September-October when it is clothed in white. *Fagara magalismontana* Engl. (RUTACEAE) is very common and varies from shrub to tree form. *Celtis kraussiana* Bernh. of the ULMACEAE grows on a variety of rock formations, including Dolomite (Fig. 23), and also on deep soil. In the latter case, it is a fairly rapid grower and develops into a fine ornamental tree, reaching a height of about 30 feet. *Mundulea sericea* (Willd.) Greenway (LEGUMINOSAE; Papilionaceae), another ornamental shrub or small tree and also very floriferous, bears large drooping racemes of purple flowers in spring.

Brachylaena rotundata S. Moore (COMPOSITAE), *Pappea capensis* var. *radlkoferi* Schinz (SAPINDACEAE) and *Combretum holosericeum* Sond. (COMBRETACEAE) are very frequent on the northern slopes of the quartzite hills north of the Vaal River; the last-named species is the only representative of a prominent genus of the Transvaal Bushveld. Low winter temperatures are probably the excluding factor to the other Bushveld species; this would also explain why only one species of *Cussonia* (ARALIACEAE), viz. *C. paniculata* E. & Z. (Fig. 19) occurs here. The wood of this species, being light and soft, is used for brake blocks for wagons. *Heteromorpha trifoliata* E. & Z. (UMBELLIFERAE), *Acacia robusta* Burch. and *Rhus gueinzii* Sond. (ANACARDIACEAE) are characteristic though they do not, as a rule, occur in large numbers.

None of these trees ever attain even local dominance, but on any quartzite hill they will be found to mingle freely. They all show a strong affinity for exposed rock. A striking demonstration of this is seen a few miles west of Potchefstroom, where a line of trees belonging to this group is strictly confined to a low outcrop of Pretoria quartzites, cutting across a level plain for about a mile and varying in width from about four to eight yards.

The smaller trees and shrubs furnish support to various ramblers and twiners, such as *Clematis brachiata* Thunb. (RANUNCULACEAE), *Sphedamnocarpus transvaalica* (Ktze.) B. Davy (MALPIGHIACEAE), *Dalechampia capensis* Spreng. (EUPHORBIACEAE), *Rhoicissus cuneifolius* (E. & Z.) Planch. (VITACEAE), *Galium horridum* Thunb. (RUBIACEAE), *Pentarrhinum insipidum* E. Mey. and *Sarcostemma viminale* R. Br. The last two belong to the ASCLEPIADACEAE and are rare.

As already noted, the disintegration of rock on the slopes has, as a rule, proceeded well beyond the stage reviewed above. Loose, angular stones are scattered on the hillside; the soil is a mixture of pebble-sized stones and sandy or loamy material with an average depth of a few inches. Tufted mountain grasses form the bulk of the herbaceous cover, while *Acacia caffra* Willd. figures as the dominant tree. True chasmophytes are absent, except where there is an outcrop of solid rock, and a great variety of herbs and suffrutices are scattered among the grasses and trees.

Among the grasses there is a conspicuous absence of dominants. On the whole, however, there is a striking similarity between the gramineous flora here and that which occurs on the chert-dolomite flats, and most species are common to both. The following are typical:—

> *Trachypogon capensis* (Thunb.) Trin.,* *Elyonurus argenteus* Nees, *Andropogon amplectens* Nees, *A. schirensis* var. *angustifolia* Stapf, *Schizachyrium semiberbe* Nees, *Cymbopogon* spp., *Monocymbium ceresiiforme* Stapf, *Heteropogon contortus* R. & S., *Themeda triandra* Forsk., *Alloteropsis semiliata* var. *ecklonii* Stapf, *Panicum coloratum* Linn., *P. natalense* Hochst., *P. stapfianus* Fourcade, *Brachiaria serrata* (Thunb.) Stapf, *B. nigropedata* Stapf, *Rhyncheletrum repens* (Willd.) Hubb., *Aristida canescens* Henr., *A. bipartita* Trin. & Rupr. and other *Aristida* spp., *Tristachya rehmanni* Hack., *T. hispida* (Thunb.) Schum., *Loudetia simplex* (Nees) Hubb., *Bewsia biflora* (Hack.) Goossens, *Eragrostis lehmanniana* Nees, *E. chloromelas* Steud., *E. atherstonei* Stapf and *E. chalcantha* Trin.

Mainly owing to the reactions produced by the arborescent population, the typical ridge now presents a great diversity of habitat. This is shown in the wide ranges of temperature and light intensity, while the soil varies in depth, texture, water-content and chemical composition. While some species of the herbaceous flora show distinct preference for some particular habitat or other, many others exhibit much greater plasticity: they may occur in various situations and are therefore represented in different stages of the succession. Hence it would not be practicable to sub-divide the list which follows according to habitat, though the group as a whole is characteristic of hills and ridges.

Pellaea hastata (Thunb.) Prantl, which usually grows in open situations and *Cheilanthes hirta* Sw. var. *contracta* Kze., typical of sheltered positions, are two common ferns.

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*[= *T. plumosus* (Kunth) Nees.]

Of the grasses, *Setaria lindenbergiana* Stapf is probably the only species confined to this habitat. It varies much in frequency, and may sometimes form a conspicuous element of the undergrowth.

Bulbostylis trichobasis C.B.Cl. (CYPERACEAE) is very common on slopes and plateaux. The blue-flowered *Commelina benghalensis* Linn. (COMMELINACEAE) and the yellow-flowered *C. africana* Linn. and *C. krebsiana* Kth. are very frequent and like partial shade.

LILIACEAE: *Aloe davyana* Schönl. often becomes dominant on overgrazed hillslopes (Fig. 21). *Drimiopsis* spp. grow in open, sunny spots as well as in shade, and on soil ranging from shallow and stony to deep. *Eriospermum* spp. are frequent and prefer humus soil in hollows among stones. In such situations the pink-flowered *Haemanthus nelsonii* Bkr. (AMARYLLIDACEAE) and *Eulophia zeyheri* Hook. (ORCHIDACEAE) with bright yellow flowers, produce striking mass-effects after good rains in spring. The same applies to *Tritonia petrophila* Bkr. (IRIDACEAE). The small-flowered *Gladiolus edulis* Burch. is very common.

The CRASSULACEAE are represented by *Kalanchoe thyrsiflora* Harv., *K. paniculata* Harv. and *Cotyledon leucophylla* C.A.Sm. A new varietal form of the last-named was found on the farm Roodekraal.

The stinging nettle, *Tragia meyeriana* Müll. Arg. (EUPHORBIACEAE) is common as undergrowth. The most frequent representatives of the MALVACEAE are *Sida dregei* B. Davy, *Hibiscus irritans* R. A. Dyer and *H. calyphyllus* Cav.

The Sympetalae form the bulk of the present group and a large number of families and genera are represented. *Plumbago capensis* Thunb. and *P. zeylanica* Linn. (PLUMBAGINACEAE), two ornamental shrubs often seen in cultivation, are both represented, the former being much more common. *Buddleia salvifolia* Lam. (LOGANIACEAE) occurs along mountain streams, but is not restricted to rocky situations.

ASCLEPIADACEAE: The shrub *Cryptolepis oblongifolia* Schltr. is rather rare, but common on stony ground at the base of a ridge on the farm Naauwpoort. Individuals of *Asclepias decipiens* N.E.Br. and *A. burchellii* Schltr. are widely scattered throughout. *Stapelia leendertziae* N.E. Br. and *Huernia loeseneriana* Schltr., both of the tribe Stapelieae, occur on the ridges north of the Vaal River. While the former seems to prefer humus soil and partial shade, the latter grows in open situations and is often rooted in rock crevices. *Caralluma lutea* N.E. Br., another member of the tribe, is more indifferent to habitat and occurs on the plains as well and on different soil types.

Evolvulus alsinoides Linn. and *Ipomoea lugardi* N.E.Br. of the CONVOLVULACEAE, have in this area been observed only on quartzite ridges in the neighbourhood of the Vaal River. *Lantana salvifolia* Jacq. (VERBENACEAE) is frequent as undergrowth and also occurs in Thorn Veld. Of the LABIATAE the commonest species are the orange-flowered *Leonotis microphylla* Skan. and *Plectranthus tomentosus* Benth.

The most frequent representatives of the SCROPHULARIACEAE are *Manulea paniculata* Benth., *M. parviflora* Benth. and *Sutera palustris* Hiern. all of which are gregarious and seem to favour sandstone and quartzite plateaux. *Sutera burkeana* Hiern. is rarer. *Cycnium adonense* E. Mey., a species with large white flowers, grows on grassy hillslopes.

Streptocarpus vandeleuri Bak. & Moore is the only member of the GESNERIACEAE in this area, and is abundant on the southern slope of a sandstone hill at Elandsfontein; elsewhere in the area, as far as is known, it is absent.

Among the ACANTHACEAE, *Thunbergia neglecta* Sond. and *Hypoestes verticillaris* R. Br. are confined to shady spots, while *Ruellia cordata* Thunb. is usually widely scattered on the grassy hillslopes.

Of the RUBIACEAE, *Oldenlandia heynei* G. Don. is perhaps best represented. *Anthospermum hispidulum* E. Mey. and *A. burkei* Sond. are frequent. *Pachystigma pygmaeum* (Schltr.) Robyns is a highly poisonous plant, and hence of considerable economic importance. Locally, it is known by various names, " gifappel ", " grysappel ", " sandappel ", " gousiektebossie " and " gifblaar ". This again illustrates how easily confusion may arise from the use of vernacular names in botany. " Gousiektebossie " is the name generally accepted for this plant, though not in this area; " gifblaar " is more generally applied to *Dichapetalum cymosum* (Hook.) Engl., a poisonous plant of the Transvaal Bushveld, while " sandappel " is locally also used for *Pygmaeothamnus zeyheri* (Sond.) Robyns, a harmless plant of similar habit. " Grysappel ", again, commonly refers to *Parinarium capense* Harv. of the ROSACEAE.

From a publication of Mes and De Villiers (1944), who made a special study of *Pachystigma pygmaeum*, it appears that in the Pretoria District, where their investigations were carried out, it occurs in grassveld and on deep soil. In this area, however, it apparently shows preference for rock; it occurs on the plateaux of ridges, and in grassveld mainly in stony places and on low outcrops.

COMPOSITAE: Although this family is much in evidence on the hills and ridges and represented by a considerable number of genera and species, the individuals, with a few exceptions, are more or less scattered and fail to attain prominence by reason of their numbers. *Helichrysum kraussii* Sch. Bip., a shrubby species, 2–3 feet high, is common and sometimes becomes dominant (Figs. 18, 20). *Cineraria albicans* N.E.Br. and *Artemisia afra* Jacq. are also more or less gregarious. *Athrixia elata* Sond. is frequent on hillslopes and widely distributed. *Helichrysum setosum* Harv.. is common; *H. lepidissimum* S. Moore and *H. callicomum* Harv. less frequent. *Vernonia staehelinoides* Harv., a handsome species, occurs in open situations. On overgrazed or otherwise denuded areas the prostrate forms of *Helichrysum*, such as *H. cerastioides* DC. and *H. caespititium* Sond., frequently make their appearance.

Protea caffra Meisn. deserves special mention. Of a large temperate genus, this is the only species represented in this area. This small evergreen tree, 4–8 feet high and usually with a single bole, frequently forms extensive consocies on quartzite or sandstone. Unlike the other trees of the ridges mentioned earlier in this chapter, it forms pure communities. The factors controlling its distribution are still very obscure and closer study may reveal interesting facts.

Although this species is characteristic of the southern slopes, it is not confined to them and frequently occurs in abundance on level plateaux (Fig. 20) and even on northern slopes. Bews (1916) remarks that the species of *Protea* composing Protea Veld prefer a loose, well aerated sandy soil, derived from sandstone or dolerite, poor in salts, especially lime.

Although this statement is broadly true of *Protea caffra* in this area, it is not in agreement with all the facts. In this area, for instance, it has never been found growing on a sandy soil, but invariably on ground which is more or less stony. At Buffelsdoorn a number of *Protea* consocies occur on the southern slope of a quartzite ridge, each strictly limited to an exposed sheet of rock (Fig. 22). It does not grow on the adjoining ground, which is composed mainly of broken stone, somewhat like a very coarse gravel; yet a few miles to the north, near Welverdiend, it flourishes on a soil type which is superficially remarkably similar.

It may also be noted that the qualities " loose, well-aerated, and poor in salts, especially lime ", accurately describe the soil of the dolomite-chert flats, from which the Protea is almost consistently absent.

One feature regarding the distribution of *Protea caffra* which appears to be fairly constant, is that it segregates itself from the other trees and shrubs of the ridges—a feature which probably cannot be accounted for by superficial examination of the habitat. It nevertheless seems to suggest the existence of some unknown factor or combination of factors, which is absent in, or adverse to one community, and present in or favourable to the other.

CHAPTER V.

GRASSVELD.

This community, characterised by the physiognomical and numerical dominance of grasses, covers practically the whole of the present area. The foregoing two communities, viz. that of the vleis and rivers and that of the hills and ridges, which represent the hydrosere and xerosere respectively, occupy only very narrow strips and relatively small patches in the grassveld formation. The Thorn Veld, i.e. *Acacia karroo* and its associates, is distinguished from the grassveld only on a basis of physiognomy; the actual composition of the grassveld is but little modified by the presence of the trees, which are low, shrubby and usually scattered.

Two distinct grassveld types can be distinguished: (*a*) Klip Veld*, i.e. mixed grassveld on stony or shallow soils, and (*b*) Sweet Veld or Themeda Veld, marked by a deep soil on which *Themeda triandra* is dominant.

The factors to which this distinction is due, appear to be mainly, if not exclusively, edaphic. The Klip Veld comprises the area covered by the Dolomite-chert formation and hillslopes on which the surface rocks have reached an advanced stage of disintegration. In each case, the substratum consists of a mass of angular stone of varying size with the intervening hollows filled with finer material, and is perhaps not unlike a stabilised talus.

In the Dolomite region, prolonged solution of the parent rock has led to the accumulation of an insoluble chert rubble, often many feet thick, though in some places the dolomite itself is exposed on the surface. The soils of this formation are dark red and frequently stained by oxides of iron and manganese. Such soils are commonly poor, being deficient in alkalies in phosphoric acid and in lime (Du Toit, 1939). Water drains through these soils with great facility, and for that reason crops show the effect of drought much sooner than in the Sweet Veld areas.

Soils of the Sweet Veld, which are derived from various rocks other than dolomite, are usually deep and vary in texture from a sandy to a clayey loam. The soils are on the whole richer in mineral salts and have better water retaining properties than those of the Klip Veld.

(*a*) KLIP VELD.—A very considerable proportion of the present area—50 per cent. is perhaps a fair estimate—is occupied by this community.

The most conspicuous characteristic of the Klip Veld is the complete absence of dominants. A rich variety of species is represented, none of which succeeds in extending its area of occupation at the expense of others. Practically every square yard contains a number of different grasses besides one or several other herbs. It is a curious mixture, not only of species, genera and families, but also of plants with diverse water requirements. The Aristidas, for instance, a xerophytic group, are generally well represented, but there is usually also a good sprinkling of Cymbopogons, which are generally classed with the mesophytic grasses. Growth form also shows a remarkable diversity. A large number of geophytes, many species with creeping stems, some shrubs, shrublets and suffrutices, and a few succulents are represented besides the numerous annual and perrenial herbs.

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* The term " Klip Veld " is locally applied to the vegetation of the Dolomite region, but is extended here to include those hillslopes which bear a similar flora.

Though this community appears to be highly unstable, there is little doubt that its heterogeneous character is determined mainly by the physical—and perhaps also the chemical—nature of the soil. The strips of vegetation within the railway fences show no higher proportion of *Themeda* (or any other dominant) than the adjoining veld, as is the case in the Sweet Veld areas; which shows that the low frequency of *Themeda* in the Klip Veld is not due to the grazing factor. Nor is there any indication that any dominant would make its appearance if burning were to be discontinued. The Klip Veld is therefore best regarded as an " edaphic climax " which is incapable of further development under current edaphic conditions.

Although the vegetation of the Dolomite zone shows a close similarity with that of the low outcrops of other rock and of the quartzite hillslopes below the chasmophytic stage, there are a few species which seem to be confined to dolomite and may therefore be regarded as true indicators of that formation. These are *Acacia mellei* Verdoorn and *Bauhinia esculenta* Burch. *Triraphis andropogonoides* (Steud.) Phill., *Pogonarthria squarrosa* Pilg. and *Eragrostis gummiflua* Nees are three grasses which, though they may be encountered outside the Dolomite area, are very characteristic of dolomitic soils, whether shallow or deep.

On the whole, the grasses of the Klip Veld afford poor grazing, except during spring and early summer. The large majority of species are " sour " grasses, i.e. their nutritive value and palatability are progressively reduced as the plants mature. Normally, by November or December the grazing value of the veld has reached its peak, whereafter it declines rapidly. Stock are generally in poor condition during the winter months unless grazing is supplemented with additional feed.

The more typical grasses of the Klip Veld are the following:—

The tribe Andropogoneae is well represented, *Andropogon schirensis* Hochst. var. *angustifolia* Stapf. and *A. amplectens* Nees being the commonest. The latter is a broad-leaved grass and of good grazing quality when young. *Schizachyrium semiberbe* Nees is very common and occurs consistently on stony ground. There is usually a good scattering of Cymbopogons: *C. excavatus* Stapf. *C. marginatus* Stapf. and *C. plurinodis* Stapf. These species, which are sometimes referred to as " stink grass ", are not readily eaten by stock, evidently because of the aromatic oils they contain. *Trachypogon capensis* (Thunb.) Trin. and *Heteropogon contortus* R. & S. are regarded as pests on account of their sharply pointed " seeds " which pierce the skins of animals. *Monocymbium ceresiiforme* Stapf. is a worthless grass; *Elyonurus argenteus* Nees is often very common but of little value. *Themeda triandra* Forsk., which affords good grazing, is usually present, but scattered and never dominant.

Alloteropsis semialata Hitch. var. *ecklonii* Stapf. is common. Although its grazing value is rather doubtful, it is one of the first grasses to resume growth after winter. *Panicum natalense* Hochst., with its rigid, wiry leaves, is a poor grass; *P. stapfianus* Fourcade (= *P. minus* var. *planifolium* Stapf) is moderate. *Brachiaria serrata* (Thunb.) Stapf. and *B. nigropedata* Stapf are early-flowering species.

Four species of *Digitaria*, viz. *D. monodactyla* Stapf, *D. argyrograpta* Stapf, *D. tricholaenoides* Stapf and *D. eriantha* Steud. are represented, but never in abundance. *Rhynchelytrum repens* (Willd.) Hubb. is very common and often attains local dominance in disturbed places on gravelly soils; *R. setifolium* (Stapf) Chiov. is less frequent. They are of little value. *Setaria perennis* Hack. and *S. flabellata* Stapf are widely scattered throughout.

A number of species of *Aristida* are represented, but with varying frequency from one locality to another. *A. diffusa* Trin. var. *burkei* (Stapf) Schweick., *A. canescens* Henr. and the ruderals *A. congesta* R. & S., *A. barbicollis* Trin. & Rupr. and *A. graciliflora* are the commonest.

Tristachya rehmanni Hack., *T. hispida* (Thunb.) Schum. and *Loudetia simplex* (Nees) Hubb. are common on hillslopes as well as on stony flats. *Microchloa caffra* Nees is frequent. *Eustachys paspaloides* (Vahl) L. & M. is widely scattered throughout. *Triraphis andropogonoides* and *Pogonarthria squarrosa* have already been mentioned. *Bewsia biflora* (Hack.) Goossens is frequent and general.

Several species of *Eragrostis* are represented. *E. chloromelas* Steud., *E. atherstonei* Stapf, *E. chalcantha* Trin., *E. capensis* (Thunb.) Trin. (= *E. brizoides* Nees) and *E. obtusa* Munro are the commonest but of little or moderate grazing value. *E. gummiflua* Nees, a coarse, unpalatable grass, is often abundant and sometimes locally subdominant in the Dolomite area. *E. superba* Peyr. is liked by stock but sparsely scattered.

(*b*) SWEET VELD.—This community occurs on the plains outside the Dolomite zone. Its continuity is interrupted by the numerous hills and ridges, and by the scattered patches of Thorn Veld; the total area of Sweet Veld is therefore relatively small.

In contrast with the Klip Veld vegetation, the Sweet Veld is characterised by either the actual or potential dominance of *Themeda triandra* Forsk. The reason why this grass has succeeded in establishing itself over vast areas in Subtropical Africa, must probably be sought in the nature of its root system. Goosens and Stapelberg (1933) describe it as, " shallowly seated and spread more or less horizontally directly below the soil surface. Here they (the roots) are very much branched, growing very much entangled, so that every millimetre of soil is occupied. For a foot or more they grow more or less parallel with the soil surface before they grow downwards, reaching a depth of approximately four feet. It has been found that the bulk of the root system occurs within the first foot from the rootstock ". Such a superficial but extremely ramified root system is eminently suited for making the fullest possible use of light showers, as these authors have observed; moreover, when a *Themeda* plant grows on or next to a more deeply rooted species, the existence of the latter is directly threatened since its water supply—and in many cases its sunlight as well—is intercepted by the former. Bews (1918) points out that *Themeda* plants are often encountered on dead tufts of deep-rooted, pioneer species of *Aristida* or *Eragrostis*.

On the other hand, *Themeda* is not very resistant to fire and uncontrolled grazing; its preservation therefore calls for a judicious and methodical farming practice.

The proportion of *Themeda* individuals in a *Themeda* community depends primarily on the condition of the veld; up to a point, the less the disturbance, the higher is the proportion. The best stands of *Themeda* have been observed in the unploughed portions of maize camps. These are, as a rule, not burned, and grazed only during late winter and in early spring until the coming of the first rains. In such pure *Themeda* associations the individual plants are massed close together with relatively little unoccupied ground and little room for other herbs. The relative number of associated plants in a *Themeda* association is therefore a reliable indicator of veld management.

Most of the numerous associated species of the Klip Veld also appear in the *Themeda* Veld when conditions are such as to offer open spaces. One species generally associated with *Themeda* is *Elyonurus argenteus* Nees. This grass usually comes in flower about September or October, and its silvery inflorescences which are rendered more conspicuous by the fact that *Themeda* flowers only some three months later, form a well-marked " vernal aspect ". Species of *Cymbopogon*, which are more robust and therefore in a position to compete successfully with *Themeda* for sunlight, are also very characteristic of the *Themeda* communities. That they may ultimately replace *Themeda* and reach a stage transitional to bush (Bews 1918, etc.) if succession were allowed to go on unchecked, is indicated by results obtained by Theron (1937) and by observations elsewhere in the area.

The economic importance of *Themeda triandra* can hardly be overrated. Phillips (1931) regards it as probably the best grazing grass found in South Africa. Bews (1918) states that although the main vascular strands in the leaves are girdered by sclerenchyma above and below, the amount of fibre is not excessive, and Henrici (1930) found it to be one of our pastoral grasses with a fair phosphorus content. With local farmers, it is common knowledge that Rooigras (*Themeda*) Veld has the highest carrying capacity.

ASSOCIATED SPECIES OF THE GRASSVELD.

A vast multitude of species, representing a large number of genera and families, enter into the composition of the Grassveld. Omitting the grasses, and not including those species which strictly belong to other communities, though they occasionally occur in the Grassveld, over 400 species, representing 54 families (Goossens-Hutchinson, 59 families), belong in this category. The largest family, the COMPOSITAE, have about 20 per cent. of the total number of species; the Papilionaceae are a close second with about 15 per cent., while each of the LILIACEAE and ASCLEPIADACEAE contribute about 7½ per cent. The Monocotyledons, with six families, 30 genera and some 60 species, are relegated to a subordinate position by the Dicotyledons.

The annuals, one-third of which belong to the COMPOSITAE, comprise about 15 per cent. of the total number of species. About 12 per cent. are geophytes, the majority of which are shared by the LILIACEAE and ASCLEPIADACEAE. The bulk of the species, however, belong to Raunkiaer's Hemicryptophytes and Chamaephytes, i.e. those perennials which renew their growth in spring from buds situated just below or just above the surface of the soil.

The Klip Veld bears a flora much richer in the frequency of individuals and in the variety of species than does the Sweet Veld, and although probably the majority of species occur in both grassveld types, there are many which seem to be associated with stony soils only.

Monocotyledons.

Of the CYPERACEAE some 10 species occur in the Grassveld, but they are never conspicuous. *Cyperus margaritaceus* Vahl, *Mariscus capensis* Schrad., *Kyllinga alba* Nees and *Bulbostylis trichobasis* C.B. Cl. are the most frequent. *Cyanotis nodiflora* Kunth (COMMELINACEAE) is common on stony ground.

The LILIACEAE comprise about 50 per cent. of the Monocotyledonous species with its geophytes in a slight majority. The individuals are seldom aggregated but usually scattered far and wide throughout the Grassveld. Practically all the species flower in spring, though in some cases the flowering period may be prolonged till late summer (*Anthericum* spp., *Bulbine* spp., etc.). The most representative are, *Bulbine asphodeloides* R. & S. and *B. narcissifolia* Salm Dyck. (both abundant in overgrazed veld), scattered individuals of *Anthericum* spp., *Albuca pachychlamys* Bkr., *Dipcadi* spp. (especially *D. polyphyllum* Bkr.), *Scilla ovatifolia* Bkr. and *Ornithogalum pretoriense* Bkr. *Eucomis undulata* Ait. usually forms small clans in shallow depressions. The summer-flowering *Aloe transvaalensis* O. Ktze. and the winter-flowering *A. davyana* Schönl. occur on various soil types and are common on flats and hillslopes. *Urginea burkei* Bkr. (Transvaal Slangkop, Fig. 26), which is highly poisonous to stock, seems to show preference for stony ground.

AMARYLLIDACEAE: *Boöphone* (= *Buphane*) *disticha* Herb. (Fig. 25) is another common poisonous plant. In this area, however, farmers do not suspect this plant of stock poisoning. It is used by local Europeans and Natives in the treatment of boils and septic wounds.

Seed dispersal of this species is effected in a very efficient way. The long pedicels, bearing the capsules, radiate from the top of the inflorescence in all directions. When the seeds have ripened, the peduncle becomes dislodged from the bulb, and the inflorescence as a whole rolls along when blown by the wind, scattering the seeds all the way.

Nerine falcata Bkr. grows gregariously, but is rare. *Crinum forbesianum* Herb. is frequent. The genus *Hypoxis* (Hypoxidaceae) is well represented, *H. rigidula* Bkr. and *H. argentea* Harv. being the commonest.

IRIDACEAE: *Gladiolus elliotti* Bkr. and *G. crassifolius* Bkr. are frequent; *Babiana hypogea* Burch. is rare.

Of the ORCHIDACEAE, *Eulophia hians* Spreng. and *E. bakeri* Rolfe are the most frequent; *E. watkinsonii* Rolfe and *Lissochilus platypetala* Lindl. are somewhat rare.

Dicotyledons.

The root parasites *Thesium hirsutum* A. W. Hill and *T. utile* A. W. Hill (SANTALACEAE) are much in evidence in the Grassveld. *T. utile* forms large tufts and is used by Natives for brooms (Burtt Davy, 1932). *Oxygonum zeyheri* Sond. (POLYGONACEAE) is widely scattered.

The commonest species of the AMARANTACEAE are the ruderals *Alternanthera repens* (Linn.) O. Ktze., *A. sessilis* R. Br. and *Gomphrena celosiodes* Mart. *Aerva leucura* Moq. is frequent in grassveld and sometimes subdominant in small localities.

Lithops lesliei N.E.Br. (AIZOACEAE, Ficoidaceae), our only " stone plant ", occurs on gravelly soil in short grassveld and has been found in various localities in this area.

The CARYOPHYLLACEAE are represented chiefly by the shrublet *Pollichia campestris* Ait. and *Dianthus mooiensis* B. Davy. The latter is common throughout the area and seldom absent from chert rises and stony outcrops. *Clematopsis stanleyi* Hutch. (RANUNCULACEAE), a handsome plant in flower, seems to be confined to stony soil. The ruderal, *Lepidium divaricatum* Sol. (CRUCIFERAE) is common.

The genus *Cleome* (CAPPARIDACEAE) is well represented in short grassveld and on stony soil. *C. maculata* B. Davy and *C. rubella* Burch. are common; *C. monophylla* Linn. is rather rare. The species of *Crassula* (CRASSULACEAE) are common in stony places; *C. transvaalensis* O. Ktze. and *C. nodulosa* Harv. are the most frequent. *Parinarium capense* Harv. (ROSACEAE) is rhizomatous and forms small patches in grassveld.

The LEGUMINOSAE comprise some 70 species in the present group. Although the family (sub-order) as a whole takes a prominent place in the composition of the Grassveld vegetation, few of the genera or species ever become conspicuous. Individual plants, representing a wide range of genera and species, are thoroughly intermixed and scattered throughout. *Bauhinia esculenta* Burch. (Caesalpinaceae) is one of the few exceptions. On the Dolomite flats it often covers considerable areas and during spring and early summer its bright yellow flowers, borne on the trailing stems up to 20 feet long, relieve the monotony of the veld. The beans, about the size of a broad-bean, are roasted and eaten by Natives and European children. In the neighbourhood of native huts it is often hard to find a single ripe pod.

Cassia mimosoides Linn., a subshrub up to one foot high, is a common pioneer on fallow land and disturbed places. There are two varietal forms, one with declinate branches, the other erect and with larger leaflets.

Elephantorrhiza elephantina (Burch.) Skeels (Mimosaceae) is gregarious. In the past its thick, red underground rootstocks were widely used by farmers for tanning.

The Papilionaceae are represented by a large number of genera and species. *Pleiospora cajanifolia* Harv. is very common. *Lotononis laxa* E. & Z., *L. uniflora* Kensit. and *L. calycina* Benth. var. *hirsutissima* Düm. are widely scattered. *Listia heterophylla* E. Mey., a frequent pioneer in disturbed areas, also occurs on ridges and along the outer margins of vleis. Isolated individuals of *Dichilus lebeckioides* DC. and *D. gracilis* E. & Z. occur throughout the Grassveld. Several species of *Crotalaria* are represented, *C. nubica* Benth., *C. lotoides* Benth. and *C. brachycarpa* (Benth.) B. Davy being the most frequent.

The genus *Indigofera* is much in evidence and a large number of species enter into the composition of the Grassveld community. Nevertheless, the individual plants are usually scattered singly throughout. The most frequent are *I. heterotricha* DC., *I. hedyantha* E. & Z., *I. burkeana* Benth. and *I. leendertziae* N.E.Br. The last species, which is very common around Potchefstroom, has been named provisionally. It makes an excellent match with the type (Leendertz 1942, locality Potgietersrust) in every respect, but differs in habit.

Tephrosia capensis (Thunb.) Pers., *T. longipes* var. *uncinata* Harv. and *T. elongata* E. Mey. are very frequent and occur in various types of habitat. *T. lupinifolia* DC. seems to be confined to outcrops of rock. *Zornia tetraphylla* Mich. var. *capensis* Harv. is a common ruderal.

Rhynchosia nervosa Benth. and *R. effusa* (E. Mey.) Druce are frequent and scattered. *Eriosema burkei* Benth. grows more or less gregariously. *Vigna stenophylla* B. Davy is better represented than *V. capensis* (Thunb.) B. Davy. *Sphenostylis angustifolia* Sond. is common and very characteristic of the slopes of chert rises.

GERANIACEAE: *Monsonia biflora* DC. and *M. burkeana* Planch. are common, especially on stony ground, and at the time of flowering, very conspicuous. *Pelargonium aconitophyllum* (E. & Z.) Harv. occurs in shallow depressions.

The POLYGALACEAE are represented by *Polygala amatymbica* E. & Z., *P. gracilenta* B. Davy and *P. hottentotta* Presl. They all seem to favour stony soils.

EUPHORBIACEAE: *Phyllanthus* spp. are common on stony outcrops. *Acalypha angustata* Sond. is very frequent on chert flats and hillslopes. This species is normally dioecious, but monoecious plants have also been found. *A. caperonioides* Baill. is less frequent The succulent *Euphorbia clavarioides* Boiss. with its crowded mass of stems, the apices of which are practically level with the soil surface, is common in several localities in the Klip Veld areas.

Zizyphus zeyheriana Sond. (RHAMNACEAE) is common in overgrazed grassveld and is dealt with at some length under " Grazing Indicators ".

Corchorus asplenifolius Burch. (TILIACEAE) is a pioneer on bare surfaces. *Triumfetta sonderi* Fic. & Hiern is abundant on the chert rises of the Klip Veld, and during late summer and autumn becomes conspicuous on account of its reddish fruits arranged in globose cymes.

Several species of *Hibiscus* (MALVACEAE) occur as scattered plants in short grassveld. *H. malacostachys* E. Mey. and *H. pusillus* Thunb. are frequent.

The genus *Hermannia* (STERCULIACEAE) is very characteristic and most of its species are confined to the Grassveld. They seem to favour open situations and short grassveld, and often act as pioneers. *H. depressa* N.E. Br. is very common throughout. *H. grandistipula* K. Sch., *H. betonicifolia* E. & Z., *H. tomentosa* Schinz and *H. lancifolia* Szysz. are frequent.

Of the THYMELAEACEAE, *Lasiosiphon capitatus* (Linn. f.) B. Davy, *L. kraussiana* Meisn. and *Arthrosolen sericocephalus* Meisn. are well represented, especially on the Dolomite flats and on hillslopes. They are among the first species to flower in spring, usually when the grass is still very short.

ONAGRACEAE: This family, in which the hygrophilous species predominate, has the naturalised *Oenothera tetraptera* Cav. in the Grassveld, usually on roadsides and other denuded places. The only species of the rather large family UMBELLIFERAE which is common in grassveld, is *Pituranthos burchellii* (Sond.) Drude.

The little shrublet, *Menodora africana* Hook. (OLEACEAE) is common, particularly on bare areas. Both *Chironia palustris* Burch. and *C. humilis* Gilg (GENTIANACEAE) occur in shallow depressions where they form dense consocies.

ASCLEPIADACEAE: This large family is represented in the Potchefstroom area mainly by Grassveld species. A feature characteristic of most of the species is the enlarged tuberous root which serves as a storage organ for water and nutrients. This organ is best developed in *Raphionacme* and in *Brachystelma* (Figs. 27, 28). In *Raphionacme hirsuta* (E. Mey.) R. A. Dyer (= *R. divaricata* Harv.), for instance, the aerial portion seems ridiculously small in proportion with the root tuber. Like geophytes generally, these asclepiadaceous geophytes are not dependent on rain for their resumption of growth after winter.

Although some species are common, the individual plants are always scattered and nowhere abundant. The following deserve mention:—

Xysmalobium brownianum S. Moore, a rare species, has been found only once during the present survey. In *Schizoglossum* are *S. biflorum* Schltr., *S. glabrescens* Schltr. and *S. periglossoides* Schltr. *Krebsia stenoglossum* Schltr. is rare and an interesting record. *Pachycarpus schinzianus* N.E. Br. is frequent, particularly in stony places; *P. rigidus* E. Mey. is rare.

The genus *Asclepias* has a large number of species, of which *A. adscendens* Schltr., *A. eminens* Schltr. and *A. fruticosa* Linn. are the commonest. The last-named is a shrub and a pioneer in various types of habitat. *Orthanthera jasminifolia* N.E.Br., a species with long, trailing stems, occurs on the Dolomite flats.

All the Brachystelmas seem to favour stony ground. With the exception of *B. ramosissimum* N.E.Br., which has a bunch of thick fleshy roots, they all have well-developed root tubers. *B. galpinii* N.E.Br. and *B. foetidum* Schltr. are fairly frequent; *B. barberiae* Harv. and *B. nanum* N.E.Br. are rare.

The genus *Ipomoea* (CONVOLVULACEAE) is represented by a number of species, and excepting *I. oenotheroides* (Linn. f.) Rafin, which is a small shrub, all have prostrate, trailing stems. They are all light demanders and therefore occur on bare areas and in short grassveld. *I. crassipes* Hook., a purple-flowered species, is common. Others are *I. ommanei* Rendle, *I. oblongata* E. Mey. var. *hirsuta* Rendle, *I. bathycolpos* Hall. and *I. obscura* Ker.

BORRAGINACEAE: *Heliotropium nelsoni* Wright is sparsely scattered in grassveld. A new *Aecidium* was discovered on a specimen of this species (*Louw* 1298) collected in this area, and described as *A. heliotropicolum* Talbot. *Trichodesma hispidum* Thunb. (T. *angustifolium* Harv.) is frequent in short veld. Others are *Cynoglossum enerve* Turcz and *Lithospermum cinereum* DC.

VERBENACEAE: *Lippia scaberrima* Sond. is frequent in the Grassveld and Thorn Veld, and sometimes becomes dominant in overstocked veld (Fig. 33). *Chascanum adenostachyum* (Schum.) Moldenke is frequent in parts and sometimes grows somewhat gregariously. *C. pinnatifidum* (Linn. f.) E. Mey. occurs on dolomitic soils. *Clerodendron triphyllum* Pears. is frequent in short veld.

LABIATAE: *Acrotome hispida* is very common. *Leucas martinicensis* R.Br. is a ruderal, often in fallow lands. *Lasiocorys capensis* Benth. is frequent on bare areas. *Salvia rugosa* Thunb. and *S. radula* (Fig. 29) are both ruderals. *Becium obovatum* N.E.Br. and *B. angustifolium* N.E.Br. are common; the latter sometimes becomes dominant along the base of ridges.

SOLANACEAE: Practically all the species of this family are ruderals or weeds of cultivation. In grassveld *Solanum panduraeforme* E. Mey. and *S. capense* Linn. are the commonest.

SCROPHULARIACEAE: *Aptosimum indivisum* Burch. and *A. depressum* Burch. are two low undershrubs, of which the former is the more frequent. *Nemesia foetens* Vent. is a handsome plant which flowers profusely. *Walafrida densiflora* Rolfe (Selaginaceae) is frequent; *W. tenuifolia* Rolfe rather rare.

The root parasite *Alectra orobanchoides* Engl. occurs on a variety of hosts, but shows particular affinity for *Becium angustifolium* N.E. Br. *Striga*, another genus of root parasites, is represented by *S. bilabiata* (Thunb.) O. Ktze., *S. elegans* Benth., *S. lutea* Lour. (red-flowered, but yellow-flowered plants are met with occasionally) and *S. gesnerioides* (Willd.) Vatke. The last-named is probably a holo-parasite since it seems to be almost or totally devoid of chlorophyll. *Graderia subintegra* Hiern., a free-blooming plant, is frequent on stony soil and perhaps worth cultivating.

ACANTHACEAE: *Chaetacanthus burchellii* Nees and *C. costatus* Nees favour stony soil. *Ruellia cordata* Thunb. is common on hillslopes. *Crabbea hirsuta* Harv., *C. angustifolia* Nees and *C. acaulis* N.E.Br. are all frequent, especially in open spaces in grassveld. This also applies to *Barleria macrostegia* Nees and *Blepharis angusta* T. Anders. *Blepharis integrifolia* (Linn. f.) E. Mey. (prostrate) and *B. squarrosa* (erect) are indicators of overgrazing. *Justicia anagalloides* T. Anders. is common on stony flats and hillslopes.

RUBIACEAE: *Pachystigma pygmaeum* (Schltr.) Robyns was mentioned in the foregoing chapter. *Oldenlandia amatymbica* (Hochst.) O. Ktze. is common, especially in stony places, and widely distributed. *Pentanisia variabilis* Harv. is common and characteristic of chert outcrops. *Pygmaeothamnus zeyheri* (Sond.) Robyns is common, particularly in the Dolomite region. Scattered individuals of *Anthospermum ciliare* Linn. and *A. rigidum* E. & Z. are frequent in stony areas. *Borreria ruelliae* K. Schum. (= *Spermacoce ruellia* DC.), an annual, is sometimes abundant in waste places.

DIPSACACEAE: *Cephalaria ustulata* var. *pilosa* R. & S. and *Scabiosa columbaria* Linn. are frequent throughout.

CUCURBITACEAE: *Citrullus vulgaris* Schrad. is common and sometimes becomes a weed in maize lands. *C. naudinianus* (Sond.) Engl. is rarer. *Cucumis hirsutus* Sond. and *C. africanus* Linn. f. are very frequent.

CAMPANULACEAE: *Wahlenbergia* spp. are frequent or locally abundant in wet depressions. *Lightfootia denticulata* Sond. is widely distributed and sometimes common. *Cyphia assimilis* (Lobeliaceae) is a frequent annual twiner. *Lobelia* spp. (Lobeliaceae) are gregarious and in favourable seasons sometimes completely dominant in shallow depressions. A magnificent sight was once witnessed in October, when several acres of a maize land near Parys was one splash of blue with *L. rosulata* S. Moore. Other species are *L. decipiens* Sond. and *L. erinus* Linn.

COMPOSITAE: With the exception only of the grasses, no other family has such a large share in the composition of the Grassland community. In the course of a short stroll through the veld, a fair proportion of the 28 genera and about 90 species is likely to be encountered.

On the stony flats and hillslopes *Vernonia kraussii* Sch. Bip. and *V. monocephala* Harv. are common. *Aster muricatus* Less., a small shrublet, sometimes becomes subdominant in overgrazed veld (Fig. 39). *A. bakerianus* B. Davy is frequent on outcrops and in stony places.

Several species of *Nidorella* occur, of which *N. resedaefolia* DC. is the commonest and often dominant in disturbed places. *Nolletia rarifolia* Steetz is frequent and scattered.

The genus *Helichrysum* is represented by a large number of species. *H. cerastioides* DC., *H. paronychioides* DC., *H. caespititium* Sond. and *H. argyrosphaerum* DC. are prostrate forms and frequent in denuded areas. The erect forms like *H. coriaceum* Sond., *H. latifolium* Less. and *H. nudifolium* Less. occur where the grasses form a denser cover. *H. rugulosum* Less. is frequent and grows on various soil types; *H. setosum* Harv. is common on hillslopes.

Stoebe vulgaris Levyns is a weed in overgrazed veld (Fig. 31). *Acanthospermum australe* (Loefl.) O. Ktze. is an exotic weed in disturbed places. Three species of *Geigeria* occur, viz. *G. burkei* Harv., *G. zeyheri* Harv. and *G. aspera* Harv. It appears that *Xanthium spinosum* Linn., a noxious weed, has been effectively controlled; at present it is comparatively rare in this area. *Zinnia multiflora* Linn. is an annual ruderal and sometimes dominant in disturbed areas. *Cosmos bipinnatus* Cav. is an escape from cultivation and has become a weed in several localities. *Schkuhria bonariensis* H. & A. and *Tagetes minuta* Linn. are common ruderals. The former is a hardier plant and invades disturbed places in the open veld; the latter seldom leaves cultivated ground, and if it does, it never makes luxuriant growth. *Pentzia globosa* Less., a shrublet, sometimes invades overgrazed veld.

The genus *Senecio*, which is of considerable toxicological importance, is represented by a number of species, practically all of which are better represented in the Klip Veld than in the Sweet Veld. The most frequent are *S. coronatus* Harv., *S. venosus* Harv., *S. serratus* Sond. and. *S. burchellii* DC. The last-named occurs on a variety of soils, including cultivated land.

Castalis spectabilis (Schltr.) Norl. (= *Dimorphotheca spectabilis* Schltr.), a very showy purple-flowered species, is frequent in parts of the area. *Osteospermum caulescens* (Harv.) Norl. (= *Dimorphotheca caulescens* Harv.) is frequent. *O. muricatum* E. Mey. and *O. scariosum* DC. (= *Tripteris glandulosa* Turcz.) are widely scattered and common throughout.

Ursinia annua Less. is a common annual in waste places. Scattered individuals of the many forms of *Gazania longiscapa* DC. occur throughout the area. *Berkheya subulata* Harv. is frequent in the Klip Veld; *B. onopordifolia* DC. occurs along roadsides and other disturbed places.

Dicoma macrocephala DC., *D. zeyheri* Sond. and *D. anomala* Sond. are frequent and scattered in the Klip Veld. A decoction of the root of *D. anomala* is locally used by Europeans for stomach troubles.

Gerbera piloselloides Cass. is scattered and common; *G. ambigua* Sch. Bip. and *G. plantaginea* Harv. are less frequent.

The genus *Sonchus* is represented by scattered individuals of *S. dregeanus* DC., *S. ecklonianus* DC., *S. nanus* Sond. and *S. rarifolius* Oliv. & Hiern. *Lactuca capensis* Thunb. and *L. dregeana* DC. are common. *Crepis hypochaeridea* (DC.) Thall. and *Hieracium capense* Linn. are both frequent; the latter is widely distributed and also occurs in dry vleis.

Fire and Grazing.

Taken as a whole, the Grassveld of the present area is in a poor state of deterioration, having a relatively low carrying capacity. While this is the outcome of both burning and excessive grazing, it is impossible to assess the proportionate amount of damage referable to each of these agencies. While there seems to be general unanimity in the condemnation of overgrazing—though the average farmer does but little to combat the evil, but accepts it with fatalistic aquiescence—on the matter of burning, there exists great diversity of opinion and this topic generally elicits much discussion. Even the results of scientific investigation are conflicting,* which tends to show that the conclusions based on burning experiments are not of universal application and that such experiments have to be executed in each particular area and for each set of environmental conditions.

The only available data for the present area have been published by Theron (1937) who carried out experiments at the Potchefstroom Agricultural College (Sweet Veld). His experiments and results can be summarised as follows, the percentage figure in each case indicating the percentage of plot area covered:—

> In Plot X, which was burned annually late in May or early in June, the area of bare ground increased from 6·7 per cent. to 41·1 per cent. in five years, while Plot XI, which was burned annually in September, the increase was from 6·4 per cent. to 53 per cent. during the same period. *Themeda triandra* showed a decrease from 35·0 per cent. to 25·5 per cent. in Plot X and from 42·8 per cent. to 19·0 per cent. in Plot XI, while *Aristida congesta*, a hardy pioneer weed, increased its area from 0·8 per cent. to 2 per cent. in Plot X and from 0·8 per cent. to 4·0 per cent. in Plot XI. In both plots *Cymbopogon plurinodis* showed a slight increase. After five years of burning, sheet erosion was evident in both plots.
>
> The control plot, which was completely rested during the period of investigation, showed some significant results. During the first two years *Themeda triandra* attained dominance and had increased its area from 38·2 per cent. to 69·6 per cent., but during the subsequent years showed a sharp drop to 8·8 per cent. This is explained by the fact that the dead straw of previous years was not removed, and on account of the low rainfall not completely decomposed; consequently the plants succumbed under a cover of partially decayed organic matter. During the period of decline of *Themeda*, *Eleonurus argenteus* showed an increase from 9·3 per cent to 36·0 per cent, *Heteropogon contortus* from 5·8 per cent. to 10·1 per cent. and *Cymbopogon* spp. from 5·4 per cent. to 25·5 per cent. The replacement of *Themeda triandra* by coarser grasses belonging to the Andropogoneae when the veld is left undisturbed, and the fact that re-establishment of *Themeda* is effected by judicious burning, has been observed in different parts of the country and noted by several authors (e.g. Bews, 1918; Phillips, 1931; Adamson, 1938). Although such protected localities are practically non-existent in this area, observations which tend to lead to similar conclusions, have been made in the course of the present study.

As stated elsewhere, controlled experiments have not been included in the present study, and conclusions had to be based on observation alone. It is therefore not possible to make authoritative statements as regards the effects of burning, since in this area these are almost invariably obscured by the operation of the other agency, overgrazing; and generally speaking, the latter is the more destructive of the two under current conditions. This is borne out by the fact that the strips of vegetation within the main road and railway fences, which are subjected to annual burning—and indiscriminate burning from the farmer's point of view—almost without exception show a more closed cover, with a higher percentage of *Themeda triandra* than the adjoining areas which are being grazed (Fig. 35).

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* For example, Hensel (1923), who conducted experiments in Kansas, U.S.A., found that after three years in his burned plot the stand was 21 per cent. heavier than in the unburned plot, and as regards its composition, there was a marked suppression of weeds

In their operation, burning and grazing differ in two important respects: (1) Grazing is selective, i.e. the palatable species, which are the most valuable, are sought out by grazing animals. If uncontrolled grazing is allowed, such species are prevented from setting seed and propagating themselves. This leads to the gradual suppression of these species to the advantage of those which are less palatable. Burning, on the other hand, is non-selective *per se*, though it is possible that in the course of time it may lead to similar results as does overgrazing, since some species (Raunkiaer's Hemicryptophytes) are more resistant to fire than others (Chamaephytes) and the latter, which includes *Themeda*, as a rule afford better grazing than the former group (*vide* Bews, 1916b).

(2) Burning is possible only at certain times of the year, and then only if the veld is in a certain state of luxuriance, i.e. if there is sufficient combustible vegetal material. This agency is therefore automatically eliminated when the veld has deteriorated beyond a certain limit. Grazing, on the other hand, may proceed without interruption practically indefinitely. Granting that there is a theoretical limit, where nature would step in and restore the biological balance, in a developed country, with its transportation facilities and other means of tiding over periods of scarcity, this point is deferred and destruction due to overstocking may continue until the veld is all but completely denuded, as is so often witnessed in town commonages.

GRAZING INDICATORS AND SECONDARY SUCCESSION ON HARD-SURFACED BARE AREAS.—The first symptoms of overgrazing are the increase of uncovered area, the reduction of palatable species and the appearance of ruderals, of which *Aristida congesta* R. & S. and *A. barbicollis* Trin. & Rupr. are the commonest.

The rate of increase of bare areas and evidence of sheet erosion are familiar features of overgrazed veld. In one of Theron's grazing experiments (l.c.) bare ground increased from 1·4 per cent. in 1928 to 16·0 per cent. in 1934 when grazed by sheep from as soon as grass was available till the end of April each year. In the Potchefstroom Area there are parts which would certainly show a much higher percentage (*vide* Figs. 32, 33, 35). The carrying capacity of such veld must be extremely low.

In the more advanced stages, woody forms (suffrutices, shrublets and shrubs) become prominent and often dominant. It is interesting to note that Clements (1928), evidently alluding to conditions prevailing in the United States, states that in the final condition grasses will have disappeared and the ground will chiefly or wholly be occupied by weedy annuals and biennials. Observations in this area do not confirm this statement. Annuals, other than grasses, though they are present in varying frequency, seldom, if ever, dominate in the final stages of overgrazed veld. Clements (l.c.) also observes that trampling is an inevitable concomitant of overstocking and frequently does more damage than the actual grazing. This would perhaps explain why in this area the hardier shrubs and shrublets survive and multiply, while the more delicate herbs, irrespective of their palatability, disappear or are kept in check if subjected to excessive trampling.

Apart from the mechanical destruction of the vegetation by the hoofs of grazing animals, trampling also modifies the soil structure. The surface layer becomes hard, compact and more impervious; consequently aeration is inhibited, run-off increased and the habitat rendered more xerophytic. The repopulation of some such areas is extremely slow.

A general feature of overstocked areas is that each overgrazed area is usually characterised by a single dominant. Whether this is due to controlling factors in the soil, or whether for some unknown reason germules of only one kind enter from adjacent areas, has not been established. The species concerned are all native, and it is therefore probable that they have originally been present in the veld as isolated individuals. It is a pity that these species, with the exception of a low proportion of *Zizyphus zeyheriana* Sond. in three plots, were not represented in the veld on which Theron's grazing and burning experiments (1937) were executed.

Zizyphus zeyheriana (Fig. 32) is a little shrublet which grows in dense clumps, since the aerial shoots, about 12 inches high, arise from a mass of woody rhizomes. Patches of it are widely scattered throughout the Grassveld, but with the disappearance of the grasses as a result of overgrazing, it gradually increases in numbers and extends the size of the clumps. Owing to the rigid, recurved spines with which the plant is armed, adequate protection against grazing animals is ensured to any plants growing among its stems. This protective function is of ecological significance. The clumps, which are up to several square yards in entent, are usually richly populated with a variety of species, including good grazing grasses like *Themeda triandra*, *Digitaria* spp. and *Panicum* spp. When the veld is rested, these clumps serve as distribution centres of seed, and regeneration is accomplished in much shorter time than would be the case if the seeds were to be introduced from adjacent areas.

The obvious question is how long it would take to suppress the *Zizyphus* and what conditions would accelerate its exit once *Themeda*-veld is restored. It shows a relatively high tolerance of shade, as it has been found growing under rather dense bushes. Root competition and burning may prove more effective. In Theron's plot, which was burned annually in September (p. 76), the area under *Zizyphus zeyheriana* was reduced from 9·1 per cent. to 3·1 per cent. in five years; the species evidently did not occur in his control plot, which is unfortunate.

Clumps of *Z. zeyheriana* usually appear to be growing on distinctly raised mounds, which is particularly noticeable in severely overgrazed veld. No doubt, sand and litter, blown by the wind, would accumulate on the clump and gradually raise it above the surrounding ground, but examination shows that sheet erosion accounts for most of the difference in height. This species therefore has considerable indicator value if an estimate has to be made to what extent the top soil has been removed.

Stoebe vulgaris Levyns (" Slangbos ") has already invaded large tracts of grassveld, not only in the Potchefstroom Area, but in the Western Transvaal fairly generally. That it is encouraged by overgrazing is conclusively demonstrated where an excessively grazed area is separated from a protected area (such as a maize camp) by a fence (Fig. 31). In some cases the contrast is very striking: On one side of the fence the *Stoebe* may be entirely lacking, while on the other side it may form such a dense, continuous cover, that if the fence were removed, it would be possible to determine its former position within a few inches, just by following the boundary between the *Stoebe* and the unaltered grassveld.

Stoebe vulgaris is a worthless plant and threatens to become a serious menace. Phillips (1939) mentions two methods of eradication, viz. the digging out of the plants and treatment with sodium chlorate. Both methods would be practicable in the initial stages of invasion, but the cost may be prohibitive once the weed has established itself over large areas. According to Cohen (1940), annual burning will not kill the plant, but frequent burning would do so. He also states that ploughing is a sure means of eradication, but points out that there is a danger that ploughing will open the ground to *Stoebe* seedlings, unless all effective sources of seed are destroyed.

The remaining grazing indicators are less important, since they are more localised or less abundant; nevertheless some of them may attain partial or absolute dominance in certain limited areas. *Lippia scaberrima* Sond. (VERBENACEAE) is widely scattered throughout the Grassveld and Thorn Veld, but on the Vyfhoek commonage, adjoining the Potchefstroom Municipal area, it has become completely dominant as a result of overstocking (Fig. 33). *Pentzia globosa* Less. (COMPOSITAE) has become dominant in various localities, while *Nesaea schinzii* var. *rehmannii* Koehne (LYTHRACEAE) is subdominant in places at Witkop and on neighbouring farms. *Aster muricatus* Less. (COMPOSITAE), a small shrublet, is rather widely distributed and sometimes subdominant, particularly in open spaces in the Thorn Veld (Fig. 39). *Pollichia campestris* Ait. (CARYOPHYLLACEAE) is more scattered, but plants increase in numbers as the original grasses become suppressed. *Ipomoea oenotheroides* (L.f.) Rafin. (= *I. argyreoides* Choisy) of the CONVOLVULACEAE and *Blepharis squarrosa* T. Anders. of the ACANTHACEAE may also be included here. The establishment of *Acacia karroo* as a result of overgrazing, will be considered in Chapter VI.

Of the herbaceous species the grasses are the commonest, with *Cynodon dactylon* Pers., *Aristida congesta* R. & S. and *A. barbicollis* Trin. & Rupr. as the most important. They are all perennials, but both of the Aristidas behave as annuals under adverse conditons. In badly disturbed areas they are therefore more in evidence in late summer and autumn than during the first part of the growing season. In the wilted condition *A. congesta* has been found to contain large amounts of prussic acid (Schweickerdt, 1941). *Cynodon dactylon* typically forms small patches, scattered throughout the disturbed area. These patches gradually increase in size as the stolons and rhizomes extend in all directions. Around homesteads and kraals it often forms a continuous cover. *Cynodon hirsutus* Stent also occurs, but is superficially rooted and spreads by means of stolons only. It is therefore much less resistant to trampling and drought than *C. dactylon*.

Eragrostis lehmanniana Nees, *E. chalcantha* Trin. and other *Eragrostis* spp. are often common, though seldom conspicuous; *E. plana* Nees often becomes dominant or subdominant on roadsides, especially on clayey soils. Other pioneer grasses are, *Tragus berteronianus* Schult., *Rhynchelytrum repens* (Willd.) Hubb. (on stony soils), *Chloris virgata* Sw. and *Aristida graciliflora* Pilg. Of the LILIACEAE, *Bulbine* spp., particualrly *B. narcissifolia* Salm-Dyck., often occur in large numbers in overstocked veld.

A common feature among the pioneer herbs on hard-surfaced bare areas is the high proportion of prostrate forms. Some species show remarkable plasticity as regards habit, which they seem to vary according to environment. *Aristida barbicollis*, for example, shows a strong tendency towards horizontal growth where the individuals are scattered on hard, bare, areas, fully exposed to the sun. Here, the culms vary from declinate to prostrate; in the latter case they radiate from the centre and are appressed to the soil. Where plants of the same species are more closely aggregated and occur on loose soil, as on fallow lands, the culms grow erect. The same peculiarity, though not in the same degree, is seen in *Chloris virgata* and in *Gomphrena celosioides* Mart.* and a few others.

The prostrate habit is well suited to this kind of habitat. The leaves are close to the soil surface, where the wind velocity is low, and are usually so arranged that only the upper surface is exposed to the sun and wind. The lower surface is in more or less close contact with the soil and protected against radiation and hot air. The mat form, which is one variation of the prostrate habit, plays a significant rôle in the succession on hard-surfaced bare areas. The mat, which is the result of repeated branching of prostrate stems, forms a close cover on the surface and acts as a mulch. Several days after a shower of rain, the soil under the mat is still moist, while the surrounding area is dry and hard. Sand and litter readily collect on the mat, and the habitat so modified, is suitable for the germination and ecesis of other plants more exacting in their requirements for moisture. The species exhibiting the prostrate habit, and the mat form in particular, are light demanders which eventually disappear when they are deprived of sunlight by the taller species which succeed them.

The following are common mat-forming species: *Alternanthera repens* (Linn.) O. Ktze. and *A. sessilis* R.Br. (AMARANTACEAE) both of which are aliens and very common in disturbed areas. Of a number of prostrate pioneers in the Papilionaceae, *Listia heterophylla* E. Mey. is perhaps the only one which forms a close cover. In protected situations this species has been observed to flower throughout winter. *Euphorbia inaequilatera* Sond. (EUPHORBIACEAE) is very common on bare ground, and therefore also a troublesome weed on paths, walks and lawns. *Corchorus asplenifolius* Burch. (TILIACEAE) is common. *Helichrysum cerastioides* DC., *H. paronychioides* DC. and *H. caespititium* Sond. (COMPOSITAE) are typical mat-forming species and common in overgrazed veld. *Acanthospermum australe* (Loefl.) Ktze. often produces such dense growth that it forms a continuous cover on the ground surface. It is common, not only on hard-surfaced areas and roadsides, but on fallow lands as well.

The following are plants with prostrate branches. Most of them have long runners on the soil surface, but they do not, except perhaps in a few cases, form continuous mats. Several species of *Ipomoea* (CONVOLVULACEAE), of which *I. crassipes* Hook., *I. oblongata* E. Mey. var. *hirsuta* Rendle, *I. bathycolpos* Hall. and *I. obscura* Ker. are the most frequent, belong here. The Papilionaceae have *Indigofera malacostachys* Benth., *I. transvaalensis* Bkr. f. (annual) and *Zornia tetraphylla* Mich. *Tribulus terrestris* Linn., which is the cause of tribulosis in sheep, is common, especially on or near homesteads. Some *Hermannia* species (STERCULIACEAE) assume the prostrate habit. *H. depressa* N.E.Br. is very common, *H. betonicifolia* E. & Z. frequent.

With the exception of some grasses already alluded to, annuals are not as a rule conspicuous on hard-surfaced bare areas. *Ursinia annua* Less. and *Schkuhria bonariensis* H. & A. are sometimes common; other ruderal annuals, which are sometimes frequent in certain localities, are *Zinnia*

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* *Gomphrena decumbens* Jacq. does not occur in South Africa as is stated in publications on South African botany. *Vide* Kew. Bull. I, 1946, p. 29.

multiflora Linn. and *Nidorella resedaefolia* DC. The latter is also a perennial if conditions permit. The annuals listed here, all belong to the COMPOSITAE.

SUCCESSION ON FALLOW LAND.

In contrast with the hard-surfaced bare areas discussed in the foregoing pages, the soil disturbed by the plough is left in a loose, friable condition, well-aerated and receptive to moisture. It is in the difference in aeration and water-content of the two types of habitat that the corresponding differences in the vegetation must be sought. Clements (1928) states, " . . . the indicators of overgrazing resemble those of old fallow fields, and there are instances in which careful scrutiny is needed to distinguish the inital cause ". In the area under review, however, the two subseres are so distinct that the initial cause can readily be determined, though admittedly some species are typical pioneers to both. The differences are particularly evident in the earlier stages. The rapid colonisation of fallow land and its dense vegetation, in which the erect form predominates, forms a striking contrast with the slow invasion of hard-surfaced bare areas on which plants are usually scattered and the prostrate form much in evidence. Fallow lands are often characterised by the predominance of annuals; in overgrazed areas this form is, as a rule, inconspicuous and the shrub form prominent.

Frequently a subsere on fallow land is dominated by a single species. In several localities *Chloris virgata* Sw. has been observed to dominate maize lands so completely as to assign the original crop to an inferior position. Similarly, dry lands and plots under irrigation along the Wonderfontein Loop are often completely invaded by *Panicum laevifolium* Hack. Both these grasses have good feeding qualities, especially the latter, which grows taller and is highly valued for its hay. It is therefore not unusual that the crop of " weeds " is more valuable than the crop for which the cultivation was intended.

Cynodon dactylon Pers. appears sooner or later to invade all cultivated ground. It is a vigorous grower and very hardy. It is, however, easily checked by winter ploughing, by which the rhizomes are brought to the surface and exposed to the frost, but on the sandy soils along the Vaal River its eradication is much more difficult owing to its deeper penetration. In cultivated land it grows much taller and is much more leafy than on bare, hard surfaces. It is regarded as a good pasture grass and is readily eaten by cattle.

A multitude of weeds, mostly alien, are quick to take possession while the land is still under cultivation. It is generally true that weeds on irrigated soil are mostly alien, whereas those of the veld are mostly native.

A more detailed treatment of weeds will be given in Chapter VIII, but it may suffice here to mention a few of the most important.

Most weeds are heavy seeders, particularly *Galinsoga parviflora* Cav., *Tagetes minuta* Lam., *Datura stramonium* Linn. and some others which, if not checked repeatedly and in time, soon cover large tracts of cultivated land. Species of *Amarantus* and of *Chenopodium* and *Portulaca oleracea* Linn., though they may occur on dry land, are confined mainly to ground under irrigation. This also applies to the grasses *Bromus catharticus* Vahl, *Eleusine indica* Gaertn., *Digitaria ternata* (Hochst.) Stapf, *Setaria verticillata* Beauv. and *Lolium multiflorum* Lam., all of which are excellent feed. *Convolvulus arvensis* Linn., *Ipomoea purpurea* (Linn.) Lam. and *Polygonum* *convolvulus* Linn. are twiners and often common in irrigated lands. *Leucas martinicensis* R.Br. and *Acanthospermum australe* (Loefl.) O.Ktze. are confined mainly to dry lands.

The genus *Aristida*, of which *A. congesta* R. & S. and *A. barbicollis* Trin. & Rupr. are the chief representatives, usually represents a later stage in the subsere on dry lands, and often becomes completely dominant. By this time, the soil has settled and has become more compact, therefore more xerophytic. At this stage, *Cynodon dactylon* may still be flourishing and extending its area.

A large, heterogeneous mixture of species now enter from the adjoining veld. *Heteropogon contortus* R. & S., *Eragrostis* spp., *Panicum coloratum* Linn., *Trichoneura grandiglumis* (Rendle) Stapf & Hubb., *Rhyncheletrum repens* (Willd.) Hubb., *Aristida scabrivalvis* Hack. and *Pogonarthria squarrosa* Pilg. are representative of the grasses. *Hyparrhenia hirta* (Linn.) Stapf is frequently represented. The following herbs and suffrutices are frequent: *Hermannia depressa* N.E. Br. (STERCULIACEAE), *Acalypha angustata* Sond. (EUPHORBIACEAE), *Indigofera malacostachys* Benth., *Rhynchosia* spp., *Tephrosia* spp. (Papilionaceae), *Cassia mimosoides* Linn. (Caesalpinaceae), *Solanum panduraeforme* E. Mey. (SOLANACEAE), *Walafrida densiflora* Rolfe (SCROPHULARIACEAE, Selaginaceae), *Barleria macrostegia* Nees (ACANTHACEAE), *Bulbine narcissifolia* Salm-Dyck (LILIACEAE).

Asclepias fruticosa Linn. (ASCLEPIADACEAE), a pioneer shrub on various types of habitat, sometimes makes its entry into fallow lands. In Fig. 30 it is shown as a co-dominant with *Cynodon dactylon*.

At this stage, the characteristic reddish patches of *Themeda triandra*, usually widely scattered, have already made their appearance. If left undisturbed, these patches gradually extend themselves eventually to cover the whole area. The time required by *Themeda triandra* for the re-occupation of undisturbed fallow lands cannot be stated with certainty, since nowhere in the area under observation could such completely re-established lands be found; moreover, farmers rarely keep record of their farming operations and are consequently seldom able to supply accurate information. The time of rehabilitation would to a large degree depend on the amount and frequency of the rainfall during that period, and is also likely to vary from one part of the district to another. Fallow lands, after about 3–4 years, are usually still in the *Cynodon–Aristida* stage.

CHAPTER VI.

THORN VELD.

This community, which is characterised by the dominance of *Acacia karroo* Hayne, is represented fairly generally on the plains outside the Dolomite zone. Bews (1925) states that the presence of Acacias in many cases is due to lime in the soil. This demand for lime, coupled with a distinct preference for deep soil—though not always confined to it—probably accounts for the absence of Acacias from the Dolomite area with its shallow soils which are deficient in lime.

According to Clements (1928), savannah owes its establishment to the wet phases of the climatic cycles. The control of the grasses is so complete that the necessary moisture for germination and ecesis of trees and shrubs is present only during the wet phase of a cycle. Once their roots have reached a greater depth than those of the grasses, the trees and shrubs persist indefinitely. Ring counts confirm the view that ecesis is normally confined to the wet phases of the climatic cycles.

This view appears to be very feasible in accounting for the existence of Thorn Veld in this area, and would justify closer study. The strip of *Acacia karroo* extending for some distance from the base of a ridge over the adjoining level plain, which is such a familiar feature of this area, possibly owes its existence to increased water-supply from the higher slopes. The run-off from the ridge, in addition to the normal rainfall, would seem to be sufficient to tip the balance in favour of the Acacias.

Any data obtained from ring counts would, however, be complicated by the fact that the ecesis of shrubs, and of the Acacias in particular, is also promoted by the elimination of the competition of the grasses. Any factor which reduces the grass population would encourage the trees and shrubs, as Clements (l.c.) has also observed. In the present area, the spread of *Acacia karroo* is in no small measure due to overgrazing, though it has not yet become a menace as *Acacia* spp. have elsewhere in the country. In severely overgrazed Thorn Veld plants of *Acacia karroo*, of all ages and sizes, occur in great abundance.

The Thorn Veld community owes its character to individuals of *A. karroo*, variously scattered and grouped, with the open spaces occupied by grasses. With similar veld management, these grasses would, with rare exceptions, comprise the same species and represent the same stage in the subsere as those of the adjoining grassveld. The trees, generally speaking, are small and appear to be under-developed in comparison with those along the Vaal River and on its islands. They are usually much-branched from the base and rarely exceed a height of 10–12 feet. Within the same community, however, a few specimens of *A. karroo*, about 20 feet in height, with well-developed boles and spreading branches, may occur. This difference in size and appearance is possibly due to a difference in age, the isolated or widely scattered clumps of the larger trees representing the progenitors of the consociation, which, in the absence of competition with others of their kind, were able to attain the fullest development under the prevailing conditions. With the reduction of the grass population as a result of overgrazing, the successive generations of the Acacias appeared in great numbers, few of which will ever develop beyond the shrub form under the stress of competition of their neighbours. Ring counts will, no doubt, furnish valuable data on the question.

Various other trees appear in the *Acacia* association, though they seldom become prominent. Most of these are deciduous and spinous. *Gymnosporia buxifolia* (Linn.) Szysz. (CELASTRACEAE), *Zizyphus mucronata* Willd. (RHAMNACEAE), *Ehretia rigida* (Thunb.) Druce (BORRAGINACEAE) and *Rhus pyroides* Burch. (ANACARDIACEAE) are the commonest. The last-named is unarmed and has rather drooping branches with a dense foliage. *Buddleja salicifolia* Jacq. (= *Chilianthus arboreus* DC.) of the LOGANIACEAE, *Acacia robusta* Burch. and *Euclea undulata* Thunb. (EBENACEAE) are less frequent. *Viscum rotundifolium* Linn. f. (LORANTHACEAE) is a common parasite on a variety of hosts, especially *Acacia karroo*.

Grewia flava DC., a low shrub, usually makes its entry into the Thorn Veld community, often in such numbers as to form a distinct association with *Acacia karroo* (Fig. 36). This *Grewia* bears sweet edible fruits and it is likely that tree-loving birds are responsible for its introduction into newly-established *Acacia* communities.

Of the climbers *Clematis brachiata* Thunb. (RANUNCULACEAE) is the commonest and frequently overtops young trees and shrubs. *C. oweniae* also occurs. *Galium horridum* Thunb. (RUBIACEAE) is frequent and *Trochomeria macrocarpa* Hook. f. (CUCURBITACEAE) rare. *Ceropegia crassifolia* Schltr. and *C. multiflora* Bkr. (ASCLEPIADACEAE) are small twiners which run into low shrubs. *Antizoma calcarifera* Miers [= *A. angustifolia* (Burch.) Miers] and *A. harveyana* Miers (MENISPERMACEAE) are common woody plants with twining tips.

Various species of *Asparagus* (LILIACEAE) are typical, the commonest being *A. suaveolens* Burch., *A. cooperi* Bkr. and *A. laricinus* Burch.

Acacia karroo and the various associated shrubs afford shade and protection against grazing animals. In such protected situations certain species occur which are not encountered in the Grassveld (Fig. 37). *Kalanchoe rotundifolia* Harv. (CRASSULACEAE), *Teucrium capense* Thunb. (LABIATAE) and *Delosperma herbium* N.E.Br. (AIZOACEAE; Ficoidaceae) are typical. *Haemanthus magnificus* Herb. (AMARYLLIDACEAE) *Bonatea speciosa* Willd. (ORCHIDACEAE) and *Talinum caffrum* (Thunb.) E. & Z. (PORTULACACEAE) are not so frequent. The shrublets *Sida dregei* B. Davy (= *S. longipes* E. Mey.) (MALVACEAE), *Lantana salvifolia* Jacq. (VERBENACEAE) and *Solanum nigrum* Linn. (SOLANACEAE) are usually represented. *Conyza podocephala* DC. (COMPOSITAE) is common. Its presence in Thorn Veld as undergrowth is probably due to the reduced rate of transpiration in the shade, since on moister ground it grows in open situations. Grasses which occur as undergrowth are *Ehrharta panicea* Sm., *Panicum maximum* Jacq. and *Digitaria eriantha* Steud. The last two also occur in open grassveld which is not severely grazed.

Acacia stolonifera Burch. is usually associated with Thorn Veld, but scattered individuals also occur sporadically in the Grassveld. The name *A. hebeclada* DC. has also been applied to the same species, which has given rise to some confusion. Pole Evans (1920, 1936), for instance, uses both names, thereby implying the existence of two distinct species. Burtt Davy

(1932), however, points out that De Candolle's name (1825) is based on Burchell's specimen No. 2267, which is part of Burchell's type of *A. stolonifera* (1824), and must therefore be relegated to synonomy. He also remarks (l.c.) that in recent years the name of *A. hebeclada* has been applied to the arborescent form as distinct from the stoloniferous form; if these prove to represent two distinct species a new name will be required for *A. hebeclada.*

In response to this suggestion, particular attention has been paid to the habit of this species in the course of the present study. The conclusion arrived at is that, though the exteme arborescent and stoloniferous forms may be separable on a basis of habit, the two forms merge into one another to such an extent, that any conceivable intermediate form may be encountered in nature. Even on the same plant the different branches may vary in habit. Fig. 38 shows a plant with one branch erect and typically arborescent, while the remaining branches are typically stoloniferous. No other differences in the two forms have been observed which are correlated with habit.

The stoloniferous forms, which may extend over 12 square yards or more, afford very effective protection against grazing animals owing to the formidable, hooked spines. On one occasion some 30 different species of herbs were counted in such a single clump, outside of which very few had any chance of survival.

CHAPTER VII.

GENERAL DISCUSSION AND FLORISTIC ANALYSIS.

That the Potchefstroom Area occupies a position within a transitional zone between different vegetation types, has been recognised by various authors in their delimitation of the botanical regions of the country. Their maps, however, differ both as regards the appellation of these regions and the position and direction of the boundary lines which separate them.

In Bews' Map of the Grass Regions (1918), the area is shown probably intermediate between the Sand Veld Region of the west and the Eastern Grassveld Region in the east, but these areas are not clearly separated on the map. The map accompanying Pole Evans' account of the distribution of Veld Types (1920) shows the area under review occupied by High Veld and just off the eastern limit of the Griqualand West Thorn Veld. In his Vegetation Map (1936), however, the entire area falls well within the Middle Veld. Finally, in Burtt Davy's map of the Transvaal (1926), a boundary line runs roughly north-south through the centre of the area, the eastern portion being designated to the High Veld, which is a subdivision of the "Warm-temperate Plateau and Montane Zones", and the western half to the Kalahari-Karroo Region, under the "Tropical and Subtropical Plateau Zone". The affinities of the Potchefstroom flora with the various vegetation types of the country will be better known when our knowledge of the distribution of species and genera is more complete.

In the preceding pages an account was given of the vegetation of the area as it exists to-day. But its composition must have undergone considerable modification as a result of European occupation. There has been a general trend towards the xerophytic. The older inhabitants relate of swampy stretches where to-day there is dry ground, and of waving grasslands where now the same plains are sparsely covered with an inferior vegetation. The Loopspruit, like several other spruits, was once a perennial stream and many of the numerous springs of the past have ceased to exist. There is evidence to show that the vegetation of even the present perennial streams has undergone considerable change. Large tracts have been cleared for cultivation, and the remaining original vegetation is subjected to continual grazing and trampling. The composition of the grasslands has been modified largely to the advantage of shrubs and weeds. It is perhaps a safe assumption that certain species have become extinct during the past half-century, while others are faced with extermination, as is at present the case with *Zantedeschia aethiopica*. On the other hand, many exotic plants have become so completely naturalised that there is nothing to betray their alien origin.

In Chapters III and IV the hydrarch and xerarch successions were followed through their various stages. The hydrosere is characterised by a series of more or less clearly defined stages, arranged in sharply demarcated zones; the successive stages of the xerosere, on the other hand, are not so sharply defined and are often blurred by local variations in the substratum. In each case, the pioneers in the initial stages are limited to one or a few species, suited for the extreme conditions of the habitat; but as the succession advances, with a resulting ameliorating effect on the habitat, a large, heterogeneous group appears upon the scene. The species intermingle freely within each of the two seres without, as a rule, any one attaining dominance. In the hydrosere this stage is represented by the mixed sedges; in the xerosere by the mixed chasmophytic tree and shrub community and the mixed sour veld of the slopes, and on continuous sheets of rock, by the xerophytic Cyperaceae, pioneer grasses, *Adromischus umbraticolus*, etc. In the succeeding stages, however, the struggle for dominance ceases and usually a single species emerges as a dominant. Such dominants are *Hyparrhenia hirta* and *Acacia caffra*. Along certain parts of the Vaal River the mixed stage is not represented, and the succession runs through the single dominants *Cyperus marginatus* and *Salix capensis* to *Acacia karroo*.

Normally, the succession culminates in the *Themeda triandra* association. Under favourable conditions, however, this community is superseded by the *Acacia karroo* association which, in this area, may be regarded as a postclimax stage. In the transitional stage between *Themeda triandra* and *Acacia karroo* the Cymbopogons and *Hyparrhenia hirta* show a marked increase in numbers, but do not. as a rule, form distinct associations or consociations. Along the Vaal River and on its islands where *Acacia karroo* dominates, the *Themeda* stage has been by-passed in the succession.

The absence of dominants is the chief feature of the Klip Veld vegetation, which shows no indication of further development and may be regarded as an edaphic climax.

The main trends of the succession in this area are shown graphically in Fig. II.

A floristic comparison with other areas in South Africa is given below. Two important facts, however, should be taken into account when comparing the richness of a flora of one area with that of another by referring to the number of known species in each. (1) A systematic equilibrium has not yet been reached, and the systematic status of plants is liable to be changed with each revision. The concepts of the taxonomic units such as *variety*, *species* and *genus* are in a large measure subjective and the designation of a plant in many cases depends on the author's concept of these units. A different number of species would therefore be recognised in the same flora at different times. Judging by general impressions only, the tendency in recent years has been to "lump" species and to "split" genera. (2) In a given region, the number of species does not vary in direct proportion with area. The smaller the area surveyed, the higher will be the number of species per unit area.

With these considerations in mind, the Potchefstroom Area compared with the regions shown below, cannot be said to be very rich in species. This may partly be accounted for by the slight variations in rainfall and altitude.

	Area, Square Miles.	Families.	Genera.	Species.
* Bolus (1905), South-western region (Cape)	35,000	110	705	5,585
* Schönland (1919), Uitenhage and Port Elizabeth	4,000	129	716	2,312
* Phillips, J. F. V. (1931), George, Knysna, Humansdorp	6,000	119	613	2,185
* Dyer (1937), Albany and Bathurst	2,300	119	647	2,084
Fourcade (1941), George, Knysna, Humansdorp, Uniondale	5,429	131	831	3,130
Potchefstroom Area	1,750	95	477	1,016

* Taken from Dyer (1937). For the purpose of comparison, the families and genera of the Potchefstroom Area are given according to Phillips' classification.

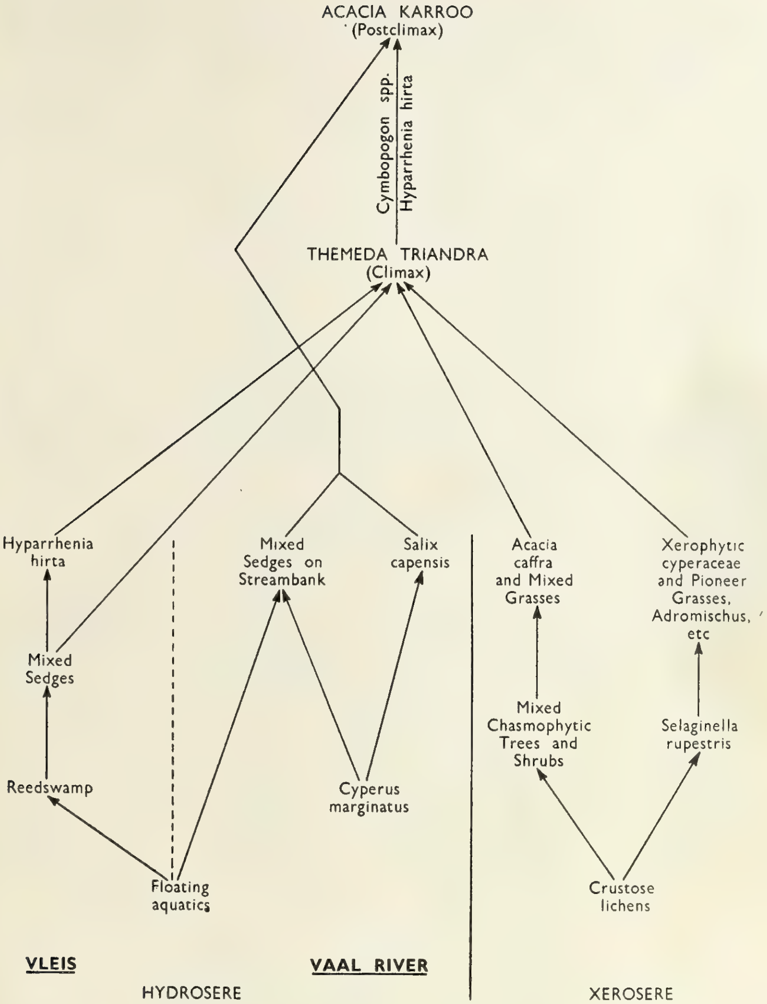

Fig. II.

The major groups are represented as follows:—

	Families.	Genera.	Species.
Gymnosperms	—	—	—
Monocotyledons	14	118	300
Archichlamydeae	53	169	345
Sympetalae	28	190	371
	95	477	1,016

In the order of numerical importance, the first ten families are the following (Phillips' classification):—

	Genera.	Species.
Gramineae	59	149
Compositae	51	126
Leguminosae	29	97
Liliaceae	20	51
Cyperaceae	13	50
Asclepiadaceae	20	42
Scrophulariaceae	22	36
Labiatae	15	26
Euphorbiaceae	7	21
Convolvulaceae	7	20

The following list shows the genera representing each family, and the number of species by which each genus is represented. Those alien species which establish themselves and multiply without the aid of man, or in spite of his efforts to exterminate them, have been included. Sporadic escapes from cultivation are excluded.

THE PHANEROGAMIC FAMILIES AND GENERA OF THE POTCHEFSTROOM AREA.

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	MONOCOTYLEDONS.		
Typhaceae	Typha	1	
Potamogetonaceae	Potamogeton	5	
Aponogetonaceae	Aponogeton	1	
Alismataceae	Alisma	1	
Hydrocharitaceae	Lagarosiphon	2	
Gramineae	Imperata	1	
	Miscanthidium	1	
	Ischaemum	1	
	Hemarthria	1	
	Trachypogon	1	
	Elyonurus	1	
	Andropogon	5	
	Sorghum	2	
	Bothriochloa	1	
	Schizachyrium	1	
	Cymbopogon	3	
	Hyparrhenia	4	
	Monocymbium	1	
	Heteropogon	1	
	Themeda	1	
	Anthephora	1	
	Tragus	3	
	Arundinella	1	
	Paspalum	4	
	Alloteropsis	1	
	Panicum	7	
	Urochloa	2	
	Brachiaria	3	
	Echinochloa	4	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Digitaria	11	
	Rhynchelytrum	2	
	Setaria	9	
	Pennisetum	1	
	Leersia	1	
	Ehrharta	1	
	Phalaris	1	
	Aristida	13	
	Sporobolus	6	
	Polypogon	1	
	Agrostis	2	
	Helictotrichon	1	
	Tristachya	2	
	Loudetia	2	
	Microchloa	1	
	Cynodon	3	
	Harpechloa	1	
	Chloris	2	
	Eustachys	1	
	Eleusine	1	
	Trichoneura	1	
	Enneapogon	1	
	Triraphis	2	
	Fingerhuthia	1	
	Phragmites	1	
	Diplachne	1	
	Pogonarthria	1	
	Bewsia	1	
	Eragrostis	20	
	Koeleria	1	
	Poa	1	
	Bromus	1	
	Lolium	1	
	Lepturella	1	
	Hordeum	2	
Cyperaceae	Cyperus	17	
	Pycreus	4	
	Mariscus	3	
	Kyllinga	3	
	Fuirena	2	
	Scirpus	10	
	Eleocharis	2	
	Fimbristylis	1	
	Bulbostylis	3	
	Cladium	1	
	Rhynchospora	1	
	Coleochloa	1	
	Carex	2	
Araceae	Zantedeschia	1	
Commelinaceae	Commelina	4	
	Cyanotis	1	
Juncaceae	Juncus	3	
Liliaceae	Bulbine	6	
	Androcymbium	1	
	Anthericum	8	
	Chlorophytum	1	
	Eriospermum	2	
	Kniphofia	1	
	Notosceptrum	1	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Aloe	3	
	Chortolirion	1	
	Tulbaghia	2	Amaryllidaceae.
	Albuca	1	
	Urginea	3	
	Drimia	2	
	Dipcadi	4	
	Scilla	3	
	Schizocarphus	2	
	Eucomis	1	
	Ornithogalum	3	
	Drimiopsis	2	
	Asparagus	4	
Amaryllidaceae	Haemanthus	3	
	Boöphone	1	
	Nerine	1	
	Crinum	2	
	Ammocharis	1	
	Hypoxis	3	Hypoxidaceae.
Iridaceae	Helixra	1	
	Moraea	1	
	Homeria	3	
	Tritonia	1	
	Babiana	1	
	Gladiolus	4	
	Lapeyrousia	2	
Orchidaceae	Habenaria	2	
	Bonatea	1	
	Lissochilus	1	
	Eulophia	4	
	DICOTYLEDONS.		
Salicaceae	Salix	2	
Ulmaceae	Celtis	1	
Proteaceae	Protea	1	
Loranthaceae	Loranthus	1	
	Viscum	1	
Santalaceae	Osyris	1	
	Thesium	4	
Polygonaceae	Emex	1	
	Rumex	4	
	Polygonum	7	
	Oxygonum	1	
Chenopodiaceae	Chenopodium	5	
	Roubieva	1	
Amarantaceae	Amarantus	4	
	Cyphocarpa	1	
..	Cyathula	2	
	Pupalia	1	
	Aerva	1	
	Achyranthes	1	
	Alternanthera	2	
	Gomphrena	1	
Nyctaginaceae	Mirabilis	1	
	Commicarpus	1	
Phytolaccaceae	Limeum	2	Molluginaceae.
	Semonvillea	1	Molluginaceae.
	Psammtaropha	1	Molluginaceae.
	Phytolacca	1	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Giesekia	1	Molluginaceae.
Aizoaceae	Delosperma	2	Ficoidaceae.
	Nananthus	1	Ficoidaceae.
	Lithops	1	Ficoidaceae.
Portulacaceae	Talinum	1	
	Anacampseros	1	
	Portulaca	3	
Caryophyllaceae	Cerastium	1	
	Spergula	1	
	Drymaria	1	
	Pollichia	1	
	Corrigiola	1	
	Herniaria	1	
	Silene	2	
	Vaccaria	1	
	Dianthus	2	
Nymphaeaceae	Nymphaea	2	
Ranunculaceae	Clematis	2	
	Clematopsis	1	
	Ranunculus	4	
	Thalictrum	1	
Menispermaceae	Antizoma	2	
Papaveraceae	Argemone	1	
	Papaver	1	
Cruciferae	Heliophila	1	
	Lepidium	3	
	Coronopus	1	
	Sisymbrium	1	
	Brassica	2	
	Raphanus	1	
	Nasturtium	1	
	Rorippa	1	
	Capsella	1	
Capparidaceae	Cleome	3	
	Gynandropsis	1	
	Boscia	1	
	Maerua	1	
Resedaceae	Oligomeris	1	
Crassulaceae	Cotyledon	1	
	Kalanchoe	3	
	Crassula	5	
	Adromischus	1	
Saxifragaceae	Vahlia	1	
Myrothamnaceae	Myrothamnus	1	
Rosaceae	Rubus	1	
	Alchemilla	1	
	Agrimonia	1	
	Parinarium	1	
Leguminosae	Acacia	6	Mimosaceae.
	Elephantorrhiza	1	Mimosaceae.
	Bauhinia	1	Caesalpinaceae.
	Cassia	2	Caesalpinaceae.
	Pleiospora	1	Papilionaceae.
	Lotononis	8	Papilionaceae.
	Pearsonia	1	Papilionaceae.
	Listia	1	Papilionaceae.
	Dichilus	2	Papilionaceae.
	Melolobium	1	Papilionaceae.
	Crotalaria	6	Papilionaceae.

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Argyrolobium	3	Papilionaceae.
	Medicago	2	Papilionaceae.
	Melilotus	2	Papilionaceae.
	Trifolium	3	Papilionaceae.
	Indigofera	18	Papilionaceae.
	Tephrosia	7	Papilionaceae.
	Mundulea	1	Papilionaceae.
	Sesbania	1	Papilionaceae.
	Astragalus	1	Papilionaceae.
	Zornia	1	Papilionaceae.
	Vicia	1	Papilionaceae.
	Neorautanenia	1	Papilionaceae.
	Erythrina	1	Papilionaceae.
	Rhynchosia	10	Papilionaceae.
	Eriosema	4	Papilionaceae.
	Vigna	5	Papilionaceae.
	Dolichos	5	Papilionaceae.
	Sphenostylis	1	Papilionaceae.
Geraniaceae	Geranium	1	
	Monsonia	2	
	Pelargonium	3	
Oxalidaceae	Oxalis	3	
Linaceae	Linum	1	
Zygophyllaceae	Tribulus	1	
Rutaceae	Fagara	1	
Malpighiaceae	Sphedamnocarpus	1	
Polygalaceae	Polygala	4	
Euphorbiaceae	Phyllanthus	3	
	Acalypha	4	
	Tragia	3	
	Dalechampia	1	
	Jatropha	1	
	Cluytia	2	
	Euphorbia	7	
Anacardiaceae	Rhus	7	
Aquifoliaceae	Ilex	1	
Celastraceae	Gymnosporia	3	
	Cassine	1	
Icacinaceae	Cassinopsis	1	
Sapindaceae	Pappea	1	
Rhamnaceae	Zizyphus	2	
Vitaceae	Rhoicissus	1	
	Cissus	1	
Tiliaceae	Corchorus	1	
	Grewia	2	
	Triumfetta	1	
Malvaceae	Modiola	1	
	Malva	1	
	Sida	4	
	Pavonia	3	
	Hibiscus	7	
Sterculiaceae	Melhania	1	
	Dombeya	1	
	Hermannia	9	
Guttiferae	Hypericum	2	Hypericaceae.
Elatinaceae	Bergia	1	
Flacourtiaceae	Kiggelaria	1	
Thymelaeaceae	Lasiosiphon	4	
	Arthrosolen	1	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
Lythraceae	Lythrum	1	
	Ammannia	2	
	Nesaea	2	
Combretaceae	Combretum	1	
Onagraceae	Jussieua	1	
	Ludwigia	1	
	Epilobium	1	
	Oenothera	5	
Halorrhagidaceae	Myriophyllum	1	
	Gunnera	1	
Araliaceae	Cussonia	1	
Umbelliferae	Hydrocotyle	1	
	Centella	1	
	Scandix	1	
	Conium	1	
	Heteromorpha	2	
	Apium	1	
	Pituranthos	1	
	Ammi	1	
	Berula	1	
	Foeniculum	1	
	Peucedanum	2	
	Pastinaca	1	
	Daucus	1	
Ericaceae	Erica	1	
Myrsinaceae	Myrsine	1	
Primulaceae	Samolus	1	
	Anagallis	1	
Plumbaginaceae	Plumbago	2	
Sapotaceae	Chrysophyllum	1	
Ebenaceae	Royena	3	
	Euclea	2	
Oleaceae	Olea	1	
	Menodora	1	
Loganiaceae	Lachnopylis	1	
	Gomphostigma	1	
	Buddleja	2	
Gentianaceae	Sebaea	3	
	Exochaenium	1	
	Chironia	2	
Apocynaceae	Landolphia	1	
	Carissa	1	
Asclepiadaceae	Cryptolepis	1	
	Raphionacme	2	
	Parapodium	1	
	Araujia	1	
	Xysmalobium	2	
	Schizoglossum	5	
	Cordylogyne	1	
	Krebsia	1	
	Pachycarpus	2	
	Asclepias	11	
	Pentarrhinum	1	
	Cynanchum	1	
	Sarcostemma	1	
	Orthanthera	1	
	Brachystelma	4	
	Ceropegia	3	
	Riocreuxia	1	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Clasification Where Different from Phillips'.
	Caralluma	1	
	Stapelia	1	
	Huernia	1	
Convolvulaceae	Cuscuta	1	
	Dichondra	1	
	Falkia	1	
	Evolvulus	1	
	Seddera	1	
	Convolvulus	3	
	Ipomoea	12	
Borraginaceae	Ehretia	1	
	Heliotropium	1	
	Trichodesma	1	
	Cynoglossum	2	
	Lappula	1	
	Lithospermum	1	
Verbenaceae	Verbena	2	
	Lantana	1	
	Lippia	2	
	Chascanum	2	
	Priva	1	
	Clerodendron	1	
Labiatae	Ajuga	1	
	Teucrium	1	
	Acrotome	1	
	Leonotis	1	
	Leucas	1	
	Lasiocorys	1	
	Stachys	3	
	Salvia	6	
	Mentha	3	
	Pycnostachys	1	
	Plectranthus	2	
	Coleus	1	
	Becium	2	
	Orthosiphon	1	
	Hemizygia	1	
Solanaceae	Lycium	1	
	Withania	1	
	Physalis	3	
	Solanum	8	
	Datura	2	
Scrophulariaceae	Aptosimum	2	
	Diascia	1	
	Nemesia	1	
	Diclis	1	
	Linaria	1	
	Manulea	2	
	Sutera	4	
	Phyllopodium	1	
	Zaluzianskya	2	
	Mimulus	1	
	Limosella	2	
	Ilysanthes	2	
	Hebenstreitia	1	Selaginaceae.
	Selago	1	Selaginaceae.
	Walafrida	2	Selaginaceae.
	Veronica	2	
	Alectra	2	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Graderia	1	
	Sopubia	1	
	Cycnium	1	
	Rhamphicarpa	1	
	Striga	4	
Pedaliaceae	Pterodiscus	1	
	Pretrea	1	
Martyniaceae	Martynia	1	Pedaliaceae.
Gesneriaceae	Streptocarpus	1	
Lentibulariaceae	Utricularia	1	
Acanthaceae	Thunbergia	1	
	Chaetacanthus	2	
	Ruellia	1	
	Crabbea	3	
	Barleria	2	
	Blepharis	3	
	Dicliptera	1	
	Hypoestes	1	
	Justicia	2	
Plantaginaceae	Plantago	3	
Rubiaceae	Oldenlandia	2	
	Pentanisia	1	
	Vangueria	1	
	Pachystigma	1	
	Tapiphyllum	1	
	Pygmaeothamnus	1	
	Pavetta	1	
	Anthospermum	4	
	Richardia	1	
	Borreria	1	
	Galium	2	
Dipsacaceae	Cephalaria	2	
	Scabiosa	1	
Cucurbitaceae	Kedrostis	1	
	Momordica	1	
	Citrullus	2	
	Cucumis	2	
	Trochomeria	1	
	Peponium	1	
	Coccinia	1	
Campanulaceae	Wahlenbergia	4	
	Lightfootia	2	
	Cyphia	1	Lobeliaceae.
	Lobelia	4	Lobeliaceae.
	Mezleria	1	Lobeliaceae.
Compositae	Vernonia	5	
	Adenostemma	1	
	Aster	4	
	Erigeron	2	
	Nidorella	4	
	Conyza	2	
	Nolletia	2	
	Brachylaena	1	
	Tarchonanthus	1	
	Denekia	1	
	Gnaphalium	2	
	Helichrysum	21	
	Stoebe	1	
	Athrixia	1	

Family. Phillips' Classification.	Genus.	Number of Species.	Family. Goossens' Classification Where Different from Phillips'.
	Pulicaria	1	
	Geigeria	4	
	Acanthospermum	1	
	Xanthium	2	
	Zinnia	2	
	Bidens	2	
	Cosmos	1	
	Galinsoga	1	
	Flaveria	1	
	Schkuhria	1	
	Tagetes	1	
	Cotula	1	
	Cenia	1	
	Schistostephium	2	
	Artemisia	1	
	Pentzia	1	
	Brachymeris	1	
	Cineraria	3	
	Senecio	17	
	Castalis	1	
	Osteospermum	3	
	Ursinia	1	
	Venidium	1	
	Haplocarpha	1	
	Gazania	1	
	Berkheya	5	
	Cirsium	1	
	Dicoma	3	
	Gerbera	3	
	Cichorium	1	
	Hypochaeris	1	
	Picris	1	
	Tragopogon	1	
	Sonchus	5	
	Lactuca	2	
	Crepis	2	
	Hieracium	1	

CHAPTER VIII.

AGRICULTURAL AND ECONOMIC ASPECTS.

In some respects farming conditions in the Potchefstroom area are decidedly unfavourable. The erratic distribution of the rainfall and the unpredictable caprices of the weather, resulting in untimely frosts, are two factors which render practically every form of agricultural enterprise highly uncertain. The soils, particularly in the Dolomite areas, are shallow and unfertile.

On the other hand, the climate is healthy and invigorating. The area is favourably situated in relation to produce markets, and the means of communication are ample and efficient. The distance from Johannesburg varies from about 40 to 100 miles. The exploitation of the gold-bearing reefs at Blyvooruitzicht and vicinity, famous for their high yield and situated well within this area, has barely begun. The main railway line from Johannesburg to the Cape passes through Welverdiend and Potchefstroom; Fochville, on the eastern border, is the terminus of a branch line from Potchefstroom. The National Road from the Cape to Johannesburg runs across the area and through Potchefstroom. The various towns and villages within and beyond the boundaries of the area, are linked up with good roads. The close proximity to densely populated centres and the existing transportation facilities invite agricultural enterprises such as dairying and the production of vegetables and flowers, which otherwise might not have been practicable.

Farmers in the area are engaged mainly in " mixed farming ", in which maize and cattle are the usual combination. Arable land is practically limited to the Sweet Veld areas, which unfortunately are our most valuable pastures. The prudence of a policy of destroying large tracts of valuable grazing for a crop to which so many risks are attached, is questionable. Kaffir corn (Sorghums), second in importance to maize as a dryland crop, is more resistant to drought, but subject to the ravages of birds which usually reduce the crop considerably. Peanuts and sunflower have been popularised during the past few years, and at this stage show signs of promise.

The natural grazing outside the Dolomite region is good. The tree-covered hills and the Thorn Veld not only afford good grazing generally, but in addition many shrubs are browsed and the pods of leguminous trees are available at a time when the value of the grasses is low. The hilly country has the added advantage of combining the sour veld of the slopes with the sweet veld of the valleys and plains; besides, shelter is afforded during winter. Some fine herds of cattle, mostly Africanders, have been bred on such farms.

The Dolomite area holds very little promise in any branch of agriculture. The surface is stony, and practically all the arable land is restricted to portions of the shallow valleys or " laagtes " between the chert rises. Soil is poor and, according to local farmers, even virgin soil is incapable of supporting a reasonable crop of maize without a liberal application of fertiliser. Water-boring is not only very expensive on account of the hardness of the rock, but highly uncertain owing to the restriction of underground water to solution channels in the dolomite.

The natural veld is sour and from late summer till spring, or later if rain is delayed, grazing is so poor that only the hardier scrub cattle can subsist on the veld and survive the rigorous winters without a supplementary ration. In this region, therefore, cattle are of a poor quality except on farms where fodder crops can be raised under irrigation. On the other hand, this veld is markedly earlier than the Sweet Veld, and in the young state, and if kept short, the grasses are on the whole both palatable and nutritious. The cutting of hay, which would appear to be the obvious solution, is ruled out by the fact that no mower can operate on such a stony terrain. Concentrated grazing at the beginning of the season would no doubt prolong the period of optimum grazing.

The only way of exploiting this region to the full, would seem to combine its grazing with that of the Sweet Veld. This is being done by a few farmers who own or hire farms in both regions. The Dolomite veld is heavily grazed during the first part of the season, while during the latter part it is allowed to rest when the cattle are transferred to the Sweet Veld.

From an agricultural viewpoint, the narrow strips of alluvium along the banks of the perennial streams constitute the most valuable land per unit area. It is here that the first European settlements arose. The soil has exceptional fertility, and practically all of it is irrigable owing to the even topography. The density of the habitations is evidence of its high productive capacity. Climate is here perhaps the only important limiting factor to agricultural potentialities.

Various farming activities are in progress. Along the Mooi River and the Wonderfontein Loop, dairying is one of the main enterprises. Milk, which is the chief product, is delivered in Johannesburg by rail and road truck daily. Before these transportation facilities were available, a cheese factory at Wonderfontein was in production for many years. A number of poultry farms produce eggs and day-old chicks.

The chief products of cultivation are wheat and lucerne. It is not clear why wheat is still so popular with many farmers. It not only fails to give the same returns per morgen as does lucerne, but is also much more uncertain. Besides being subject to rust, it involves the risk of hail and in the best of circumstances birds take a considerable share. Lucerne is grown both for the market and for the home dairy cows. Cereals of lesser importance are oats, barley and rye. Vegetables and fruit are not grown on an extensive scale.

Irrigation from the Vaal River has great possibilities, but as yet little use has been made of its water for this purpose. Steep banks and a fluctuating water level are technical difficulties which can be overcome only by powerful machinery and large capital. Farmers usually make use of windmills to pump water from boreholes, but for the purpose of irrigation such supplies are naturally very limited.

The sandy soils of the farms bordering on the Vaal River are well suited to certain crops like tobacco and grapes. Both of these are grown fairly generally, though not on a large scale. The usual product of the vineyards is alcohol which is distilled by the farmers themselves.

Grazing afforded by the streams and vleis is of the best in the area. The herbaceous species form a closed, continuous cover, and very little space is unoccupied. The grasses rank high in grazing value and many species of the Cyperaceae are browsed. Clements (1928) supplied tables which show that the sedges run higher in protein and carbohydrates than the grasses, although they are less palatable. *Salix babylonica* and *S. capensis* are browsed, and in spring their leaves and succulent twigs are relished by cattle.

PLANTS OF ECONOMIC IMPORTANCE.

None of the trees of the area, native or naturalised, yield a suitable timber, though *Populus canescens* Sm., which readily propagates itself when once established in vleis and along streams, is extensively used for roof-poles and rafters for farm buildings and native huts. The wood is light and durable, straight and of even thickness. The commoner trees, like the Acacias, *Zizyphus mucronata*, *Rhus pyroides* and *Combretum holosericeum* are mostly used for firewood. *Acacia caffra* is sometimes used for fencing poles. *Salix babylonica* has a light, soft wood, which is suitable for brake-blocks and mortars for pounding maize and kaffir corn. *Rhus lancea* (evergreen), *Celtis kraussiana* (deciduous) and *Acacia karroo* (deciduous) are fine ornamental trees sometimes found in cultivation.

Hyparrhenia hirta is the grass most widely used for thatching. *Phragmites communis* is used for the same purpose, but a top layer of *Hyparrhenia* is necessary to render the thatch waterproof. *Hyparrhenia auctus* and *H. glauca* are excellent for thatching, but they occur in limited quantities.

Brief notes on the economic uses of other plants have been given under family headings in the ecological account.

Weeds of Cultivation.—A considerable increase in the production cost and a substantial reduction in the yield of cultivated crops of the area can directly be attributed to weeds. This applies particularly to crops under irrigation, since firstly, the water requirements of most weeds are relatively high, which accounts for the absence of many species, mostly aliens, from dry land; secondly, the running water aids in the dispersal of their seeds. It is possible that the seeds or fruits of all the weeds of the area are in some measure conveyed from one place to another by running water.

Weeds in general, and annuals in particular, are capable of reproducing their kind in great abundance and with surprising rapidity. Hence, when left to the weeds, it is usual to find considerable areas dominated by a single species; only rarely do more than one or two species of equal prominence grow intermixed. The best examples of such species, which by virtue of their enormous seed production, are able to take quick possession of cultivated land, are *Chenopodium* spp., *Amarantus* spp., *Portulaca oleracea* Linn., *Lolium multiflorum* Lam., *Ipomoea purpurea* (Linn.) Lam., *Leucas martinicensis* R.Br. (dry lands), *Physalis angulata* Linn., *Datura* spp. *Erigeron canadense* Linn., *Acanthospermum australe* (Loefl.) O. Ktze., *Xanthium* spp., *Bidens* spp., *Cosmos bipinnatus* Cav., *Galinsoga parviflora* Cav., *Flaveria contrayerba* Pers. and *Tagetes minuta* Linn.

While many weeds produce flowers and seeds at an even rate throughout the growing season, some, like *Tagetes minuta*, *Bidens* spp., *Flaveria contrayerba* and others, show a strong tendency to terminate their vegetative functions in favour of reproduction at the approach of winter, irrespective of size or age. This must probably be correlated with the phenomenon of photoperiodicity and is perhaps best exhibited in *Tagetes minuta*. In autumn plants of this species, from barely three inches high, up to over six feet, burst into flower and set their seeds. The agricultural application is therefore the destruction of such plants before general anthesis.

Delayed germination of the seeds of weeds is a wellknown fact. In the cocklebures this is accomplished in a special way (*vide* Hargue in " Ecology ", Vol. II, 1921). In lands of the Potchefstroom Agricultural College which had periodically been cleared of *Datura* for ten years, during which time no plant was allowed to seed, isolated plants of this weed still made their appearance (" Boerdery in Suid-Afrika ", Aug., 1937). This also illustrates the extraordinary viability of its seeds.

The obvious method of control is to destroy the weeds before they set seed. Those weeds, however, which perennate in and multiply by means of underground vegetative organs, are much more difficult to deal with. Such are the bulbiferous *Oxalis* spp., *Cynodon dactylon* (rhizomes), *Cyperus esculentus* (suckers during summer; tubers) and *Physalis viscosa* (rhizomes).

" Prevention is better than cure " is as sound a maxim in the fight against weeds as in any field of pathology. Weeds are introduced into cultivated land mainly in three ways: with the seed of cultivated crops, with irrigation water and with manure. The first source is rendered negligible by screening farm seeds if impurities are suspected, or by obtaining seeds from reputable firms. Proper control to ensure the destruction of weeds at drinking places and along irrigation canals, will greatly diminish the danger of infestation from these sources. Farm manures are perhaps the most important single cause of infection. The seeds of most weeds pass through the digestive tracts of animals unimpaired, and they retain their viability over long periods in the kraal. When, however, the fresh manure is used in the making of compost, the heat generated in the process of decomposition is sufficient to destroy the seeds of any weed. This is only one of the advantages of composting, a practice unfortunately too little known in this area.

Many weeds show effective resistance to frost, and if their vegetative processes cease during winter, it is not so much on account of the low temperatures as for lack of water. Among these are *Polygonum plebeium* R.Br., *P. aviculare* Linn., *Chenopodium* spp., *Coronopus integrifolius* Spreng., *Euphorbia inaequilatera* Sond., *Oxalis corniculata* Linn., *Poa annua* Linn., *Lolium multiflorum* Lam. and *Sonchus oleraceus* Linn. In moist situations, as along water furrows and damp places in the garden, these species live throughout winter, apparently unaffected by the cold.

Parasitic weeds of the area are *Cuscuta campestris* Yunck. and *Striga lutea* Lour. It is possible, according to Saunders (1934) that, with the exception of the stalk borer, *S. lutea* is responsible for a greater reduction in the yield of maize and Sorghums in the Union than all the fungus diseases and insect pests together.

Weeds are not of necessity without their economic value; in fact, many of them are escapes from cultivation, e.g. *Cosmos bipinnatus* Linn., *Cichorium intybus* Linn. and *Vicia sativa* Linn. The following make good feed for farming stock: *Panicum laevifolium* Hack., *Brachiaria isachne* (Roth) Stapf, *Digitaria* spp., *Setaria verticillata* Beauv., *Cynodon dactylon* Pers., *Chloris virgata* Sw., *C. pycnothrix* Trin., *Eleusine indica* (Linn.) Grtn., *Bromus catharticus* Vahl, *Lolium multiflorum* Lam., *Amarantus paniculatus* Linn., *A. thunbergii* Moq., *Portulaca oleracea* Linn., *Vicia sativa* Linn., *Bidens pilosa* Linn. and *B. bipinnata* Linn. *Melilotus albus* Desr. and *M. indicus* All. are nutritious, though not very palatable. *Tagetes minuta* Linn., which in the fresh state will not be touched even by hungry animals on account of its strong aromatic odour, is reported by several farmers to make excellent ensilage. Natives cook the young tops of *Gynandropsis pentaphylla* DC., *Amarantus thunbergii* and *A. paniculatus* as greens.

Poisonous Plants.—It cannot be said that farming losses due to the poisonous plants of the area are very considerable, though outbreaks of plant poisoning are more severe in some years than in others. A much higher mortality among farming stock than is actually the case, could be expected if it were not for the fact that the animals appear to possess some sense of discrimination by which they distinguish poisonous from edible plants. Anyone who has watched sheep grazing in a patch of *Homeria* will know how dexterously the edible herbage is selected from the tangle of " tulp " leaves. A disagreeable taste in poisonous plants does not offer a complete explanation for this behaviour, since animals newly introduced into areas to which they are unaccustomed, are much more likely to ingest poisonous plants than those which are familar with the environment. When however, no other green herbage is available, animals seem to be unable to resist the temptation of partaking of the harmful plants. Underground storage organs, which are a general feature among poisonous plants, enable such plants to renew growth after winter before the edible species of the veld have sprouted. For this reason, cases of poisoning are practically confined to the dry spring months.

The following is a list of the most important poisonous plants of the area. In many cases, however, farmers are by no means unanimous in their opinion regarding the toxicity of these plants:—

EQUISETACEAE: *Equisetum ramosissimum* Desf., a hygrophilous species, occurs along the Mooi and Vaal Rivers. Although its effects are not fatal, it is believed to produce giddiness and a kind of intoxication in the animals that eat it, in which state they are liable to meet with accidents. Steyn (1934) was successful in producing the typical disease in sheep by feeding 800 gm. of the plant to them, but the tests of other investigators showed negative results.

GRAMINEAE: Several grasses produce hydrocyanic acid (prussic acid), usually on wilting, which causes " geilsiekte ", a fatal disease in sheep. On the authority of Steyn (1.c.), the following grasses of the area contain various amounts of prussic acid in the wilted state: *Anthephora pubescens* Nees, *Aristida congesta* R. & S., *Cynodon dactylon* Pers., *Eustachys paspaloides* (Vahl) L. & M., *Digitaria eriantha* Steud., *Pogonarthria squarrosa* Pilg. and *Themeda triandra* Forsk.

LILIACEAE: *Urginea burkei* Bkr. (" Transvaal slangkop ") (Fig. 26) is a grassveld species which seems to prefer stony soils. In some years it causes heavy losses among stock in spring. All the parts of the plants have been found to be poisonous. Investigations conducted in England have proved it unsuitable as a raticide (Steyn, 1.c.).

AMARYLLIDACEAE: *Haemanthus amarylloides* Jacq. occurs on the heavy soils of dry vleis. A sheep drenched with 500 gm. of the fresh bulbs and leaves, died about 24 hours after administration (Steyn, 1.c.).

Boöphone disticha Herb. (" Gifbol ") is scattered singly throughout the Grassveld. Various authors have recorded the use by Bushmen and Hottentots of preparations of the bulb for arrow-poison. Natives of the Orange Free State use the bulb for suicidal purposes (Watt and Breyer-Brandwijk, 1932). Steyn (1934) points out that the fact that the leaves are browsed by stock without apparent ill-effects, is no proof that they are non-toxic, as non-toxic amounts may be eaten.

IRIDACEAE: *Homeria pura* N.E.Br. sometimes forms dense consocies in the outer zone of the vlei vegetation. Farmers regard all " yellow tulps " as highly poisonous to stock. Steyn (1.c.) found that 700 gm. of the fresh corms and leaves of *H. pallida* in the flowering stage killed a full-grown sheep two hours after administration.

RANUNCULACEAE: *Ranunculus pubescens* Thunb. has been proved to be poisonous, expecially in the flowering stage. Steyn (1.c.) suggests that it varies in toxicity from one locality to another. In this area it is not considered harmful; in Fig. 7 a cow can be seen in the background, grazing in a dense patch of *R. pubescens*.

LEGUMINOSAE: Mimosaceae: The seeds of *Elephantorrhiza elephantina* (Burch.) Skeels (" Elandsboontjie ", " Elandswortel ") are poisonous, 250 gm. being a lethal dose to sheep (Steyn, 1.c.).

Papilionaceae: *Crotalaria burkeana* (" Stywesiektebossie "), which occurs in grassveld, but rare in this area, is the cause of " stywesiekte " in cattle. According to Dragendorff, the seeds of *Mundulea sericea* (Willd.) Greenway (locally called " keurboom "), a common shrub on quartzite ridges, are used as a fish poison (Steyn, 1.c.), while according to Pammell, the bark and root contain a very toxic glucoside (Watt and Breyer-Brandwijk, 1.c.).

ZYGOPHYLLACEAE: *Tribulus terrestris* Linn. (" Devil's Thorn ", " Duwweltjie ") is the cause of tribulosis (" geeldikkop ") in sheep. According to Steyn (l.c.), at certain times of the year and in different years, this plant may not only be perfectly harmless but an excellent feed, whilst at other times it is the cause of most severe outbreaks of the disease. Climatic, and to a certain extent soil conditions, he suggests, play an important rôle in the determination of the toxicity of the plant.

SOLANACEAE: The leaves of *Datura stramonium* Linn. (" Stinkblaar ", " Olieboom ") are used medicinally by natives and Europeans in the treatment of sores and various ailments. Death in humans as a result of ingesting the seeds, either unwittingly with contaminated cereals, or by children through playfulness, has been reported in the press at various times, or recorded elsewhere. As regards animals, Steyn (l.c.) states that carnivora are more susceptible than cattle and horses.

RUBIACEAE: Many of the local farmers regard *Pachystigma pygmaeum* (Schltr.) Robyns (" Gousiektebossie ") as the most noxious plant of the area. Mes and De Villiers (1944) have pointed out that " gousiekte " does not necessarily occur in areas where the plant grows, from which is inferred that the degree of its toxicity varies from one area to another. It is also worthy of note that one year of very severe outbreaks of the disease may be followed by several years in which losses are small or negligible.

Mes and De Villiers (l.c.), after conducting eradication experiments for two summers, arrived at the following conclusions, which are briefly: (1) Where conditions permit, the digging out or ploughing under of the plants is effective. (It need be mentioned here that in the Potchefstroom area this method would not be possible in the majority of cases, since the plants seem to show preference for stony situations). (2) The results of the praying experiments were disappointing. (3) Sprinkling with solid $NaC10_3$

and NAC1 proved more effective, but a serious objection to dusting with NAC10$_3$ is that the grass is also eradicated for the following season. In any case, the methods mentioned under (2) and (3) would not justify the cost. Finally the authors conclude that the eradication of the plant is not absolutely necessary and refer to Mr. E. du Toit's scheme, which has been applied with success, and of which the essentials are, paddocking and heavy grazing for short periods. This grazing scheme ensures that the poisonous leafage consumed by each animal is less than the lethal amount. Steyn (1934) recommends the reservation of pastures infested by *Pachystigma pygmaeum* for winter grazing, since the aerial parts of the plant are readily killed off by frost.

COMPOSITAE: *Castalis spectabilis* (Schltr.) Norl., a grassveld species, is not abundant in the Potchefstroom Area. Steyn (l.c.) states that the minimal lethal dose of the fresh plant for full-grown sheep is 100–130 gm. As far as could be established, farmers of the area do not suspect this plant of poisoning their stock.

Of the three Geigerias of the area, Steyn (l.c.) found *G. aspera* Harv. and *G. zeyheri* Harv. to cause " vermeersiekte " (vomiting sickness) in sheep, but no mention is made of the third, *G. burkei* Harv. He also states that experimental evidence showed *G. aspera* to be the most toxic of all the *Geigeria* spp. investigated. The toxicity of *G. zeyheri* shows a curious seasonal variation, being highest in December and January, while during the period February to September the experiments showed negative results.

The genus *Senecio* is of considerable toxicological importance in this country. Our knowledge concerning the toxicity of the various species, which number well over 200, is still incomplete, but it is known that " bread poisoning " in man, and " Molteno disease " in cattle and horses and " dunsiekte ", " stomach staggers ", " grass staggers ", etc. in horses are cases of *Senecio* poisoning. Species of this area which have been proved to be poisonous, are *S. burchellii* DC. and *S. sceleratus* Schweick. The latter is, according to Steyn (l.c.), " by far the most toxic species of *Senecio* encountered in South Africa ". The following species, which also occur in this area, were investigated by Steyn at Onderstepoort with negative results: *S. albanensis* Harv. (vix DC.), *S. othonnaeflorus* DC. and *S. venosus* Harv. *S. venosus* poisoning in a native, approximately 30 years of age, was once witnessed by the author. A plant was produced which proved to be *S. venosus*, the leaves of which he had boiled as a beverage, obviously having confused it with some other harmless plant. The most prominent symptom was severe abdominal pain, which disappeared several hours after an emetic had been administered repeatedly.

BIBLIOGRAPHY.

(Excluding a large number of publications consulted in connection with taxonomic studies.)

Adamson, R. S.	" The Vegetation of South Africa ". London, 1938.
Allard, H. A.	" Length of Day in Relation to the Natural and Artificial Distribution of Plants ". *Ecology*, XIII, 3: 1932.
Arber, A.	" Water Plants ". Cambridge, 1920.
Bayer, A. W.	" The Relationship of Vegetation to Soil Erosion in the Natal Thorn Veld ". *S.A. Journ. Sc.*, XXX, 1933.
Bayer, A. W.	" An Account of the Plant Ecology of the Coastbelt and Midlands of Zululand ". *Ann. Natal Mus.*, VIII, 3: 1938.
Bennett, H. H.	" Soil Conservation ". New York, 1939.
Bennett, H. H.	" Soil Erosion and Land Use in South Africa ". Union of S. Afr., Dept. Agric., 1945.
Bews, J. W.	" An Account of the Chief Types of Vegetation in South Africa, with Notes on the Plant Succession ". *Journ. of Ecol.*, IV, 3 and 4: 1916a.
Bews, J. W.	" The Growth Forms of Natal Plants ". *Trans. Roy. Soc. of S. Afr.*, V, 5: 1916b.
Bews, J. W.	" The Grasses and Grasslands of South Africa ". Pietermaritzburg, 1918.
Bews, J. W.	" Plant Forms and Their Evolution in South Africa ". London, 1925.
Bews, J. W.	" The World's Grasses ". London, 1929.
Cannon, W. A.	" General and Physiological Features of the Vegetation of the More Arid Portions of Southern Africa, with Notes on the Climatic Environment ". Carnegie Inst. No. 354: 1924.
Chippendall, L. K. A.	" The Common Names of Grasses in South Africa ". Union of S. Afr., Dept. Agric. Bull. No. 265: 1946.
Clements, F. E.	" Plant Succession and Indicators ". New York, 1928.
Clements, F. E. and Weaver, J. E.	" Experimental Vegetation ". Carnegie Inst. No. 355: 1924.
Clements, F. E., Weaver, J. E. and Hanson, H. C.	" Plant Competition ". Carnegie Inst. No. 398: 1929.
Cohen, C.	*Stoebe vulgaris*. A Study of an Ecological Problem. *Journ. S. Afr. Bot.*, 1940.
Cooper, W. S.	" The Fundamentals of Vegetational Change ". *Ecology* VII, 4: 1926.
Cottle, H. J.	" Studies in the Vegetation of South-western Texas ". *Ecology* XII, 1: 1931.
Davy, J. B.	A Manual of the Flowering Plants and Ferns of the Transvaal with Swaziland ". Pts. I, II. London, 1926, 1932.
De Swardt, S. J. and Burger, O. E.	" National Provision against Drought ". Union of S. Afr., Dept. Agric. Bull. No. 235: 1941.
Drabble, H.	" Plant Ecology ". London, 1937.
Du Toit, A. L.	" Geology of South Africa ". Edinburgh, 1939.
Dyer, R. A.	" The Vegetation of the Divisions Albany and Bathurst ". Bot. Survey of S. Afr. Memoir 17: 1937.
Drought Investigation Commission	" Final Report ". Cape Times, Ltd., Cape Town, 1923.
Evans, I. B. Pole	" The Veld: Its Resources and Dangers ". *S.A. Journ. Sc.* 17: 1920.
Evans, I. B. Pole	" A Vegetation Map of South Africa ". Bot. Survey of S. Afr. Memoir 15: 1936.
Fick, J. C.	" Skending van die Grond-, Veld- en Waterbronne van Suid-Afrika ". Cape Town, 1944.
Fourcade, H. G.	" Check-List of the Flowering Plants of the Divisions of George, Knysna, Humansdorp and Uniondale ". Bot. Survey of S. Afr. Memoir 20: 1941.

Geisler, S. " Soil Reactions in Relation to Plant Successions in the Cincinnati Region ". *Ecology*, VII, 2: 1926.

Glover, P. E. " A Contribution to the Ecology of the High Veld Flora ". *S.A. Journ. Sc.*, XXXIV, 1937.

Goossens, A. P. " The Grasses of the Orange Free State ". (Unpublished MS.).

Goossens, A. P. and Stapelberg, W. J. " A Brief Note on the Macroscopic Aspect of some Western Transvaal Grasses ". *S.A. Journ. Sc.*, XXX, 1933.

Henrici, M. " The Phosphorus Content of Grasses in the Eastern Transvaal ". 16th Report Dir. Vet. Serv., Pretoria, 1930.

Henrici, M. " The Transpiration of Different Plant Associations in South Africa: Part I. Transpiration of Karroo Bushes: Part II. Indigenous and Exotic Trees. under Semi-Arid Conditions: Part IV. Parkland, Forest and Sour Mountain Grassveld. Large Karroo Bushes ". Union of S. Afr. Sc. Bulletins Nos. 185 (1940), 248, 244 (1946).

Henrici, M. " Fodder Plants of the Broken Veld ". Pt. II. Union of S. Afr., Dept. Agric. Sc. Bull. No. 213: 1940.

Hensel, R. L. " Recent Studies on the Effect of Burning on Grassland Vegetation ". *Ecology*, IV, 2: 1923.

Hutchinson, J. " The Families of Flowering Plants, I ". Dicotyledons. London, 1926; II. Monocotyledons. London, 1934.

Hutchinson, J. " A Botanist in Southern Africa ". London, 1946.

Marloth, R. " The Flora of South Africa ". Vols. I-IV. Cape Town and London, 1913–1932.

Mes, M. G. and de Villiers, E. The " Gousiektebossie ". A Study of the Morphology, Physiology and Eradication of *Pachystigma pygmaeum* (Schltr.) Robyns. Union of S. Afr., Dept. Agric. Sc. Bull. No. 245: 1944.

Pentz, J. A. " The Value of Botanical Survey and the Mapping of Vegetation as Applied to Farming Systems in South Africa. Bot. Survey of S .Afr. Memoir 19: 1938.

Pentz, J. A. " Soil Erosion Survey of the Reclamation Area in Natal ". Union of S. Afr., Dept. Agric. Sc. Bull. No. 212: 1940.

Phillips, E. P. " A Preliminary List of the Known Poisonous Plants found in South Africa ". Bot. Survey of S. Afr. Memoir 9: 1926.

Phillips, E. P. " An Introduction to the Study of South African Grasses with Notes on their Structure, Distribution, Cultivation, etc." Central News Agency, S. Afr., 1931.

Phillips, E. P. " The Weeds of South Africa ". Union of S. Afr., Dept. Agric. Bull. No. 195: 1938.

Pickford, G. D. " The Influence of Continued Heavy Grazing and of Promiscuous Burning on Spring-fall Ranges in Utah ". *Ecology* XIII, 2: 1932.

Potts, G. and Tidmarsh, C. E. " An Ecological Study of a Piece of Karroo-like Vegetation near Bloemfontein ". *Journ. of S.A. Bot.*, II: 1937.

Raunkiaer, C. " The Life Forms of Plants and Statistical Plant Geography ". Oxford, 1934.

Robb, R. L. " Grassland Development in South Africa ". Univ. Pretoria, 1936.

Robertson, C. " Flowers and Insects ". *Ecology* VIII, 1: 1927; IX, 4: 1928.

Rowland, J. W. " Notes on the Study of Plant Succession in Relation to Grazing ". *S.A. Journ. Sc.* XXX, 1933.

Rowland, J. W. " Investigations into the Productivity and Management of the Natural Veld and Permanent Pasture on a certain Soil Type in the Pretoria District ". Union of S. Afr., Dept. Agric. Sc. Bull. No. 203: 1939.

Saunders, A. R. " Studies oor Fanerogamiese Parasitisme, met Spesiale Verwysing na *Striga lutea* Lour.". Union of S. Afr., Dept. Agric. Sc. Bull. No. 128: 1934.

Saunders, A. R. " Field Experiments at Potchefstroom ". Union of S. Afr., Dept. Agric. Sc. Bull. No. 14: 1942.

Schantz, H. L. " Drought Resistance and Soil Moisture ". *Ecology* VIII, 2: 1927.

Schonken, J. D. " Effective Rainfall ". S.A. Journ. Sc., 22: 1925.

Schönland, S. " Phanerogamic Flora of the Divisions of Uitenhage and Port Elizabeth ". Bot. Survey of S. Afr. Memoir 1: 1919.

Schönland, S. " South African Cyperaceae ". Bot. Survey of S. Afr. Memoir 3: 1922.

Schweickerdt, H. G. " An Account of the South African Material of *Aristida* Linn. in Certain European and South African Herbaria ". *Bothalia* IV: 1941.

Scott, J. D. " Veld Management in South Africa ". Union of S. Afr., Dept. Agric. Bull. No. 278: 1947.

Shreve, F. " Physical Conditions in Sun and Shade ". *Ecology* XII, 1: 1931.

Steyn, D. G. " Factors Concerned in the Determination of Toxicity of Plants ". *S.A. Journ. Sc.* XXX: 1933.

Steyn, D. G. " The Toxicology of Plants in South Africa ". Central News Agency, S. Afr., 1934.

Talbot, W. J. " Swartland and Sandveld ". Cape Town, 1947.

Tansley, A. G. and Chipp, T. F. " Aims and Methods in the Study of Vegetation ". London, 1926.

Theron, G. C. " Veld Management Investigations at the School of Agriculture, Potchefstroom ". Union of S. Afr., Dept. Agric. Bull. No. 166: 1937.

Tomlinson, F. R. " Profitability of Irrigation Farming in the Western Transvaal ". Union of S. Afr., Dept. Agric. Bull. No. 201: 1939.

Van der Merwe, C. R. " Soil Groups and Sub-Groups of South Africa ". Union of S. Afr., Dept. Agric. Sc. Bull. No. 231: 1941.

Verdoorn, I. C. " Edible Wild Fruits of the Transvaal ". Union of S. Afr., Dept. Agric. Bull. No. 185: 1938.

Various Authors " The Geology of Ventersdorp and Adjoining Country ". Union of S. Afr., Dept. of Mines, Geol. Survey: 1935.

— " The Geology of the Country Around Potchefstroom and Klerksdorp ". Union of S. Afr., Dept. of Mines, Geol. Survey: 1939.

— " A Guide to Botanical Survey Work ". Bot. Survey of S. Afr. Memoir 4: 1922.

Warming, E. " Oecology of Plants ". Oxford, 1909.

Watt, J. M. and Breyer-Brandwijk " The Medicinal and Poisonous Plants of Southern Africa ". Edinburgh, 1932.

Weaver, J. E. " Root Development in the Grassland Formation ". Carnegie Inst. No. 292: 1920.

Weaver, J. E. " Some Ecological Aspects of Agriculture in the Prairie ". *Ecology* VIII, 1: 1927.

Weaver, J. E. and Clements, F. E. " Plant Ecology ". New York, 1929.

Weaver, J. E. and Flory, L. " Stability of Climax Prairie and Some Environmental Changes Resulting from Breaking ". *Ecology* XV, 4: 1934.

ILLUSTRATIONS

Photographs by the Author

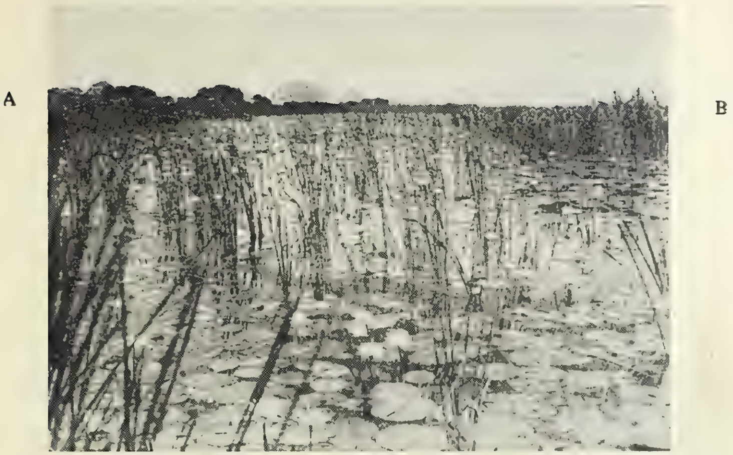

FIG. 1.
Vlei at Bank Station. Central zone: *Nymphaea nelsonii* dominant, but its territory is being invaded by *Typha australis*. A, *Scirpus corymbosus*; *B*, *Phragmites communis*.

December.

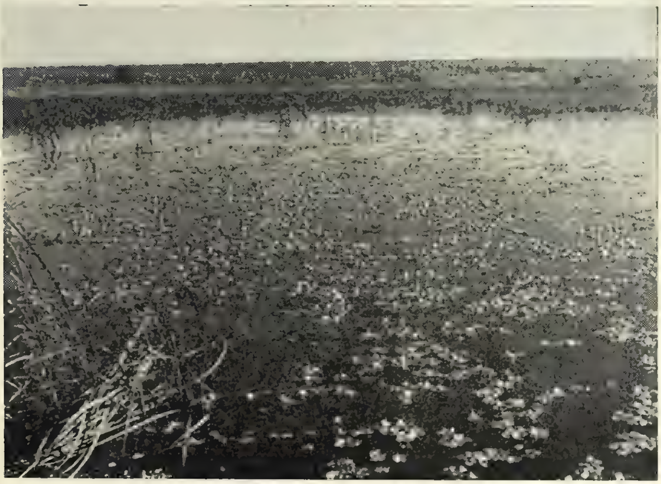

FIG. 2.
Seasonal pan at De Beerskraal: *Ilysanthes conferta* (determination ex descr.) in open water, 2 feet deep, surrounded by *Diplachne fusca* (in left foreground and background).

April.

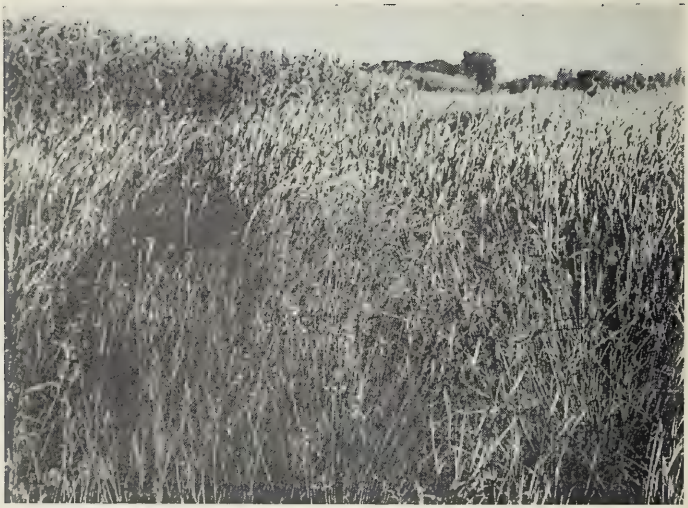

FIG. 3.

The Mooi River at Frederikstad. Foreground: *Scirpus corymbosus*; background: *Typha australis*; left, in distance, *Phragmites communis*. Note the density of the vegetation.

January.

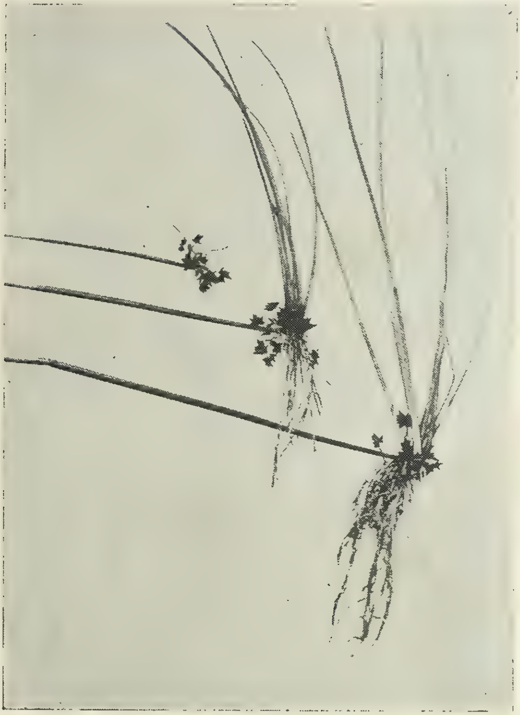

FIG. 4.

Vivipary in Scirpus corymbosus: 3 inflorescences showing different stages of development of young plants. The tallest was 20 inches high.

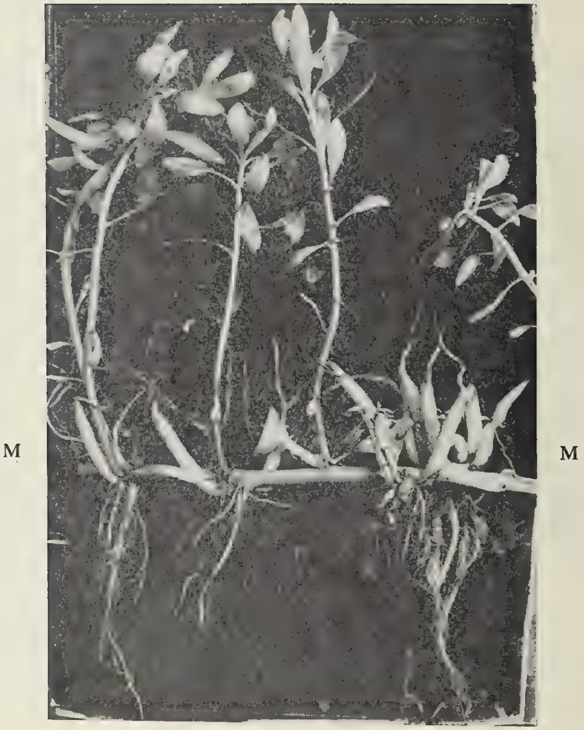

Fig. 5.
Jussieua diffusa showing air roots arising from main stem, which was buried in mud. M-M, mud-level.

December.

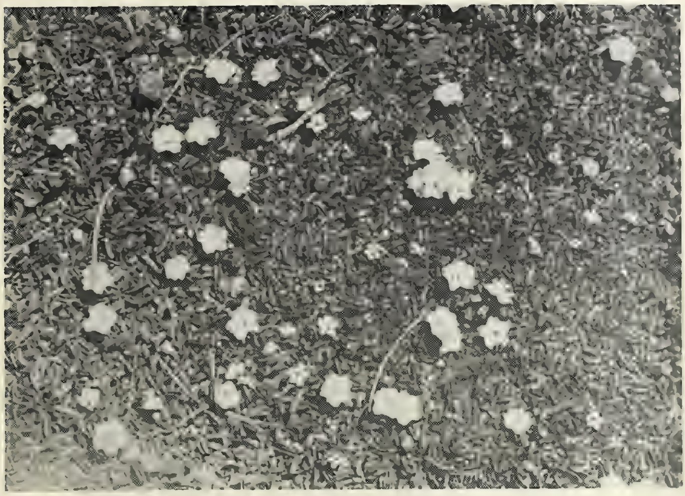

Fig. 6.
Part of a dense mat of *Falkia oblonga* on the bank of a spruit near Boskop Station. (About $\frac{1}{3}$ natural size).
September.

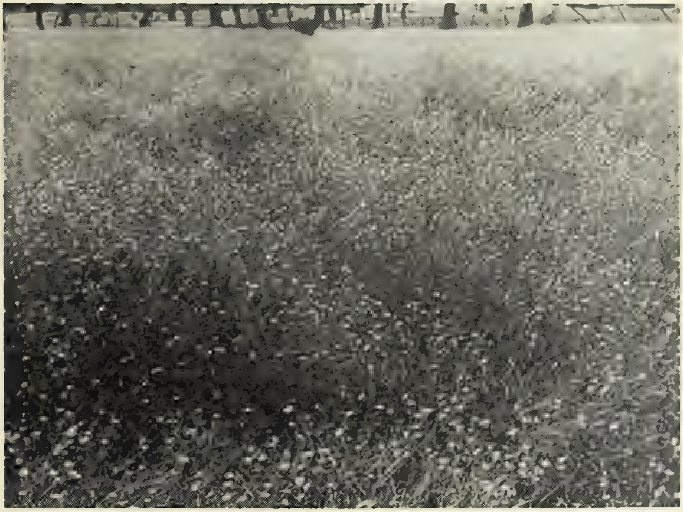

Fig. 7.
A pure consocies of *Ranunculus pubescens* on low-lying ground, adjoining a vlei.
November.

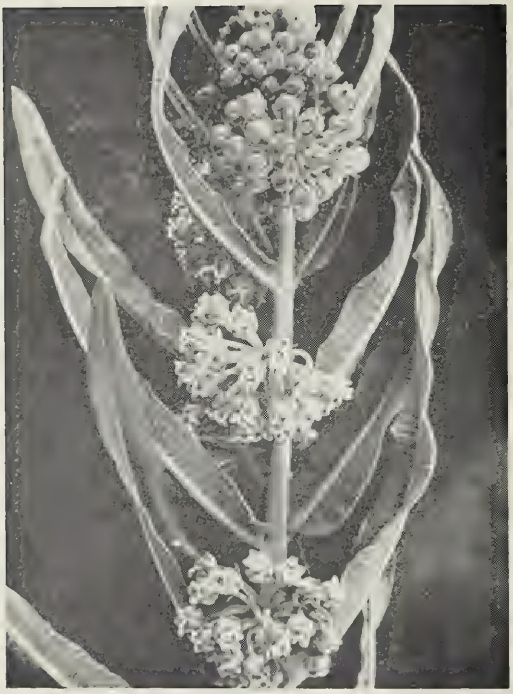

Fig. 8.

Xysmalobium undulatum, frequent on the higher slopes of vleis.

December.

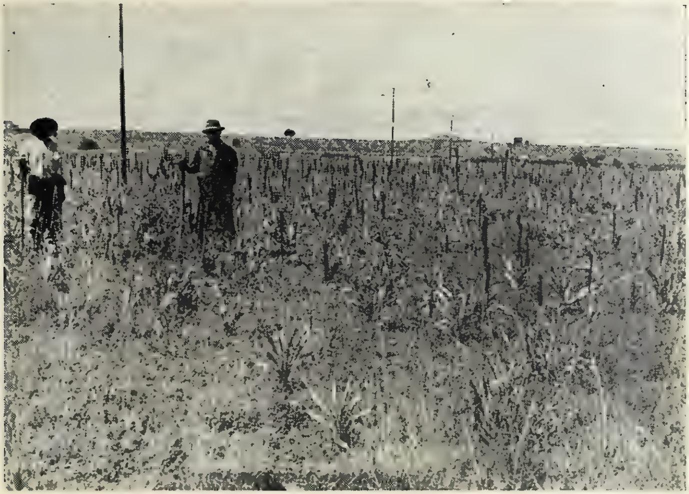

FIG. 9.

Notosceptrum natalense in flower on black, alluvial slopes of Klein Loopspruit. The spruit is faint in the background.

March.

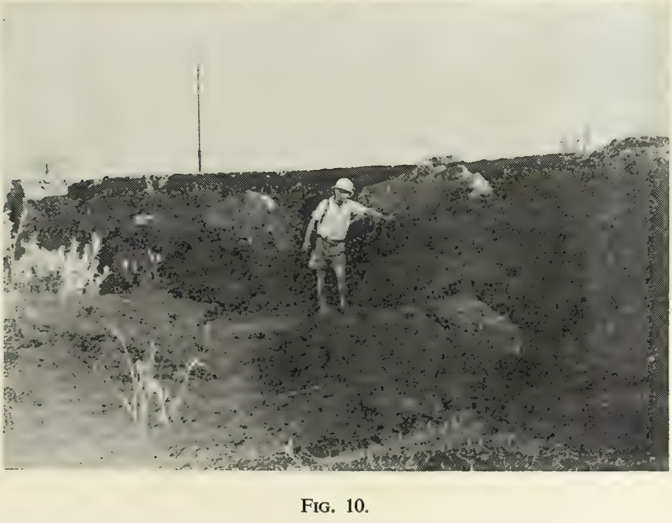

FIG. 10.

A bend in the Klein Loopspruit at Roodekraal, showing the collapse of many tons of rich alluvium. As a result of overstocking, the soil binders have disappeared. *Asclepias fruticosa* on raised portions of streambed, left.

October.

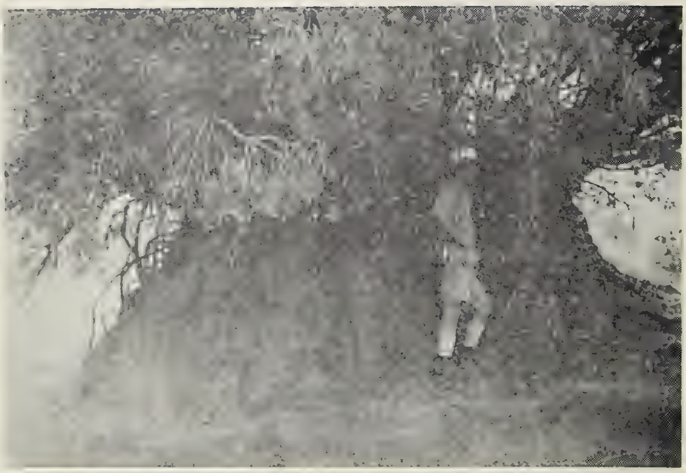

FIG. 11.

But for the roots of this *Royena* clump, tenaciously holding their 6 foot high mass of earth, there is nothing in the neighbourhood to indicate to what extent the soil surface has been lowered by sheet erosion. Near the Vaal River at Scandinavia Bridge. *March.*

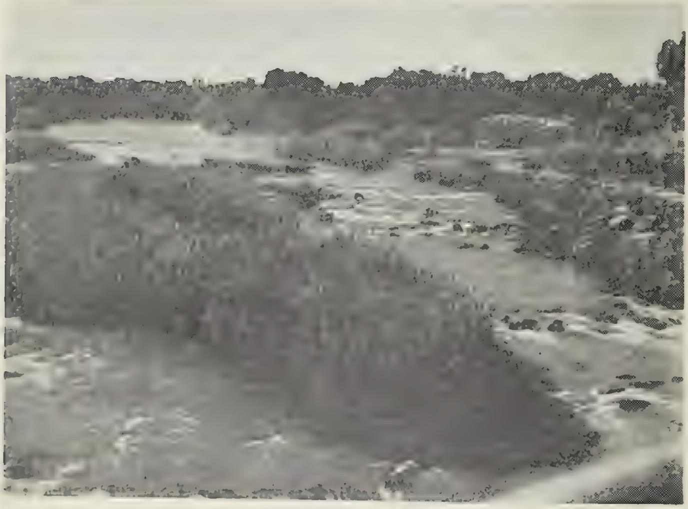

FIG. 12.

Part of the Vaal River at Parys, showing the numerous islets at normal water-level, covered chiefly with *Phragmites communis* (in flower) and *Cyperus marginatus.* On the river-bank (in the background), *Salix capensis* and *S. babylonica.* May.

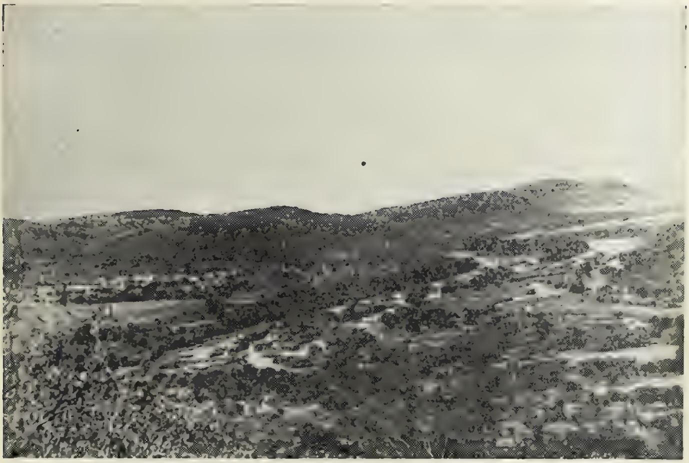

FIG. 13.

The Vaal River at Nooitgedacht, looking south from the top of a hill. Note the many islands and the thickly wooded river-banks.

October.

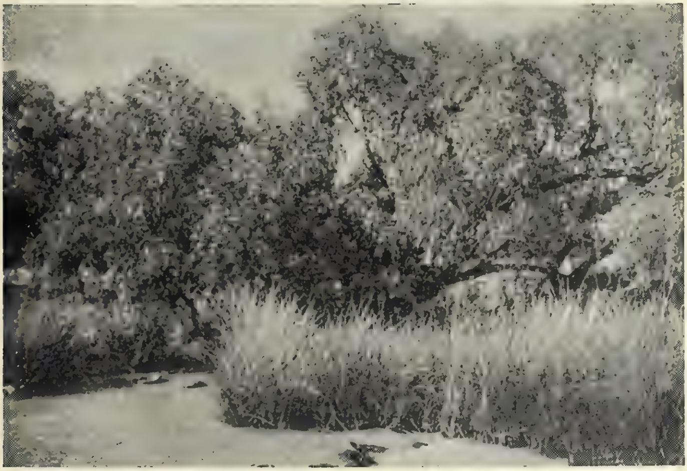

FIG. 14.

Close-up of an island in the Vaal River. Foreground: *Cyperus marginatus*; Background: *Salix capensis*.

October.

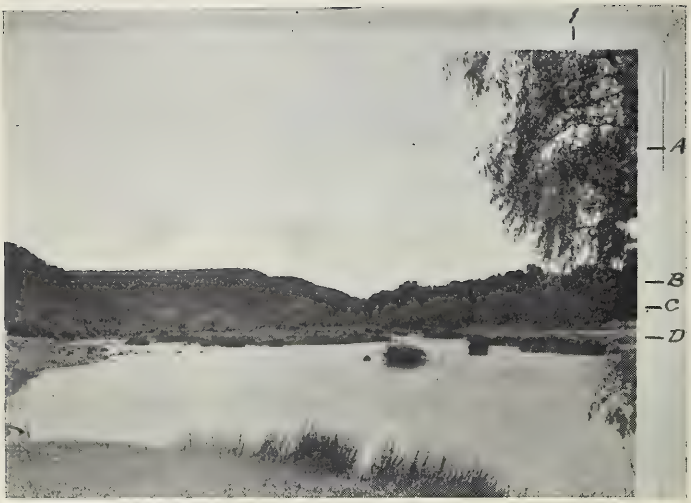

Fig. 15.
Overlooking a stream of the Vaal River. Note the zonal distribution of the vegatation.
1 A, *Salix capensis* in foreground; B, *Acacia karroo* and C, *Salix capensis* on the larger islands in the background; D, smaller islands with *Cyperus marginatus*.
December.

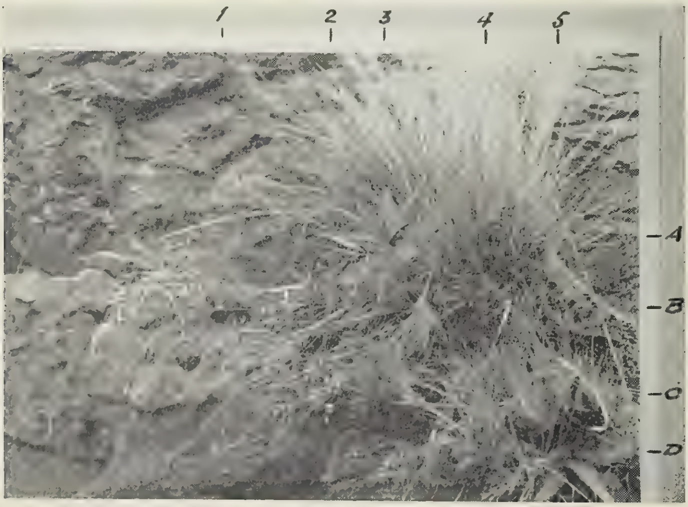

Fig. 16.
Early stages in the lithosere.
1 B, *Pellaea hastata* on *Selaginella rupestris*; 2 C, 4 B, *Adromischus umbraticolus*; 3 B, 3 C, *Cheilanthes hirta* var. *contracta*; 4 A, *Aristida spectabilis*; 3 A, 5 D, *Aloe davyana*.
March.

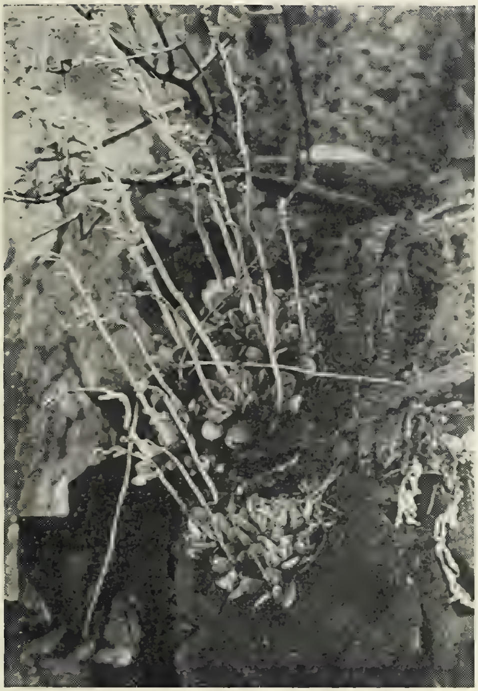

Fig. 17.
Adromischus umbraticolus in shallow humus pockets in rock; shaded.

November.

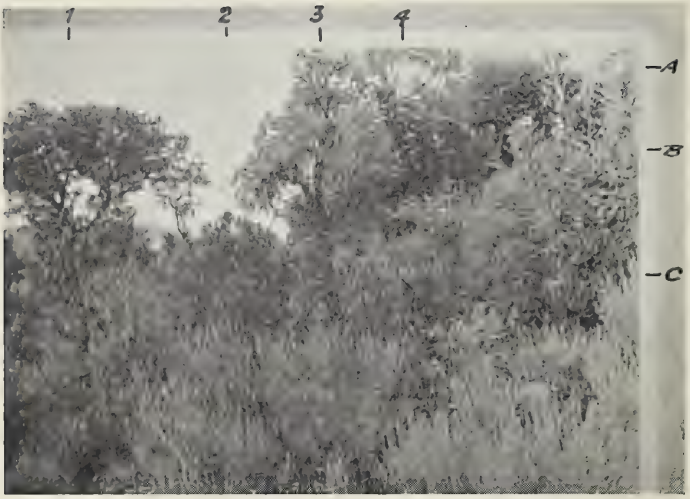

Fig. 18.

Western slope of ridge at Nooitgedacht.

1 B, *Mundulea sericea*; 2 C, *Combretum holosericeum* (young tree); 3 B, *Cussonia paniculata*; 4 A, *Brachylaena rotundata*; foreground: *Helichrysum kraussii.*

March.

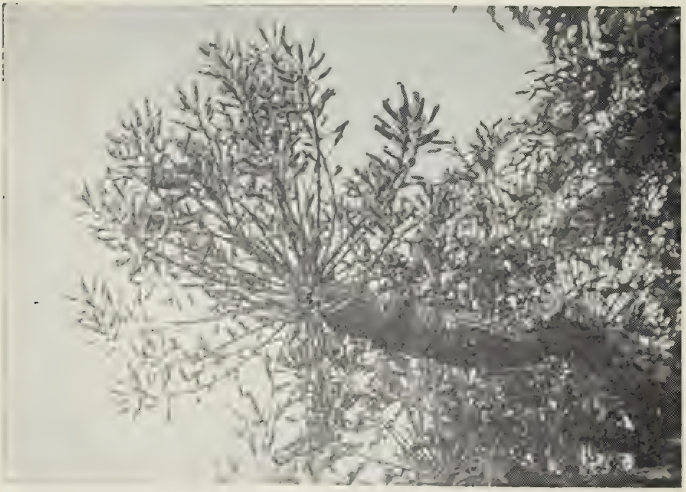

Fig. 19.

Cussonia paniculata: Inflorescence arising from the apex of a branch which projects horizontally from the tree. Under a lens several of the myriads of buzzing flies, which pollinate this species, are discernible.

April.

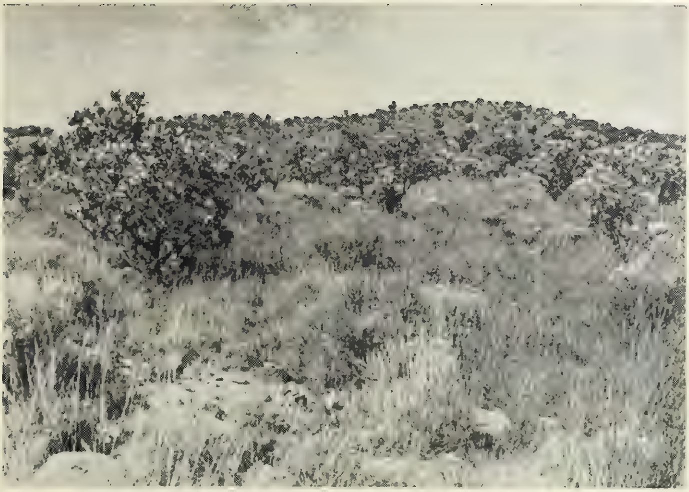

FIG. 20.

Protea caffra—Helichrysum kraussii community on a quartzite plateau. Grasses in the foreground: *Trachypogon plumosus*, *Schizachyrium semiberbe*, *Heteropogon contortus*.

March.

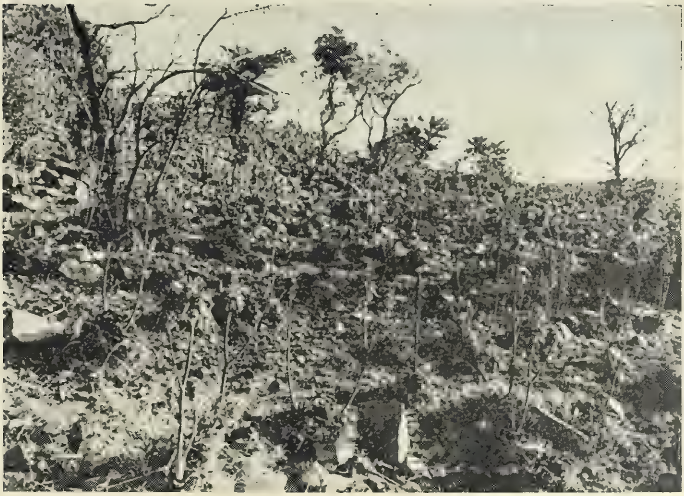

FIG. 21.

Aloe davyana completely dominant on overgrazed hillslope near Roodekraal. Trees: *Acacia caffra*.

July.

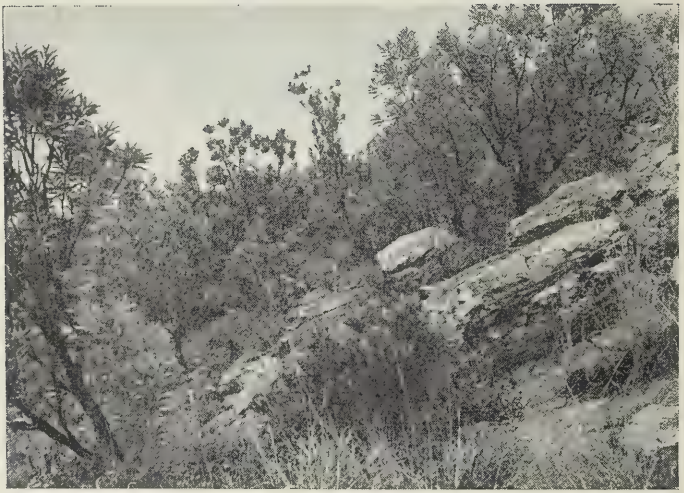

FIG. 22.

Part of one of the dense patches of *Protea caffra* on the southern slope of a quartzite hill at Buffelsdoorn. The trees are strictly confined to exposed rock.

January.

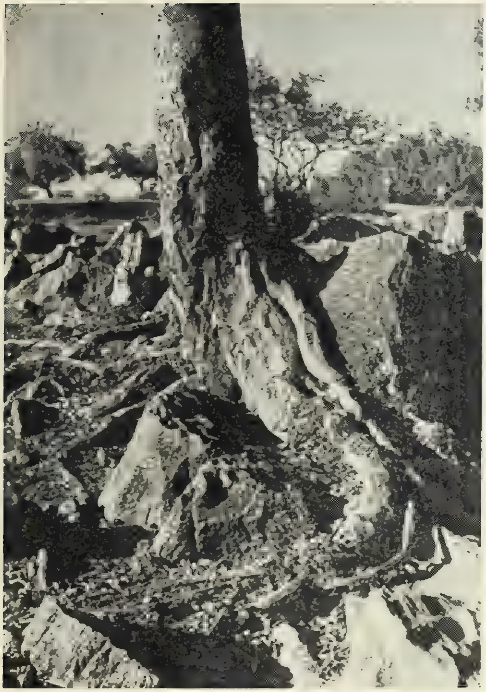

FIG. 23.

Celtis kraussiana rooted in dolomite at Gerhardminnebron Eye. The relatively steep gradient and excessive trampling have accelerated the weathering of the rock, resulting in the exposure of the main roots. Note the dense covering of young shoots sprouting from the exposed roots.

May.

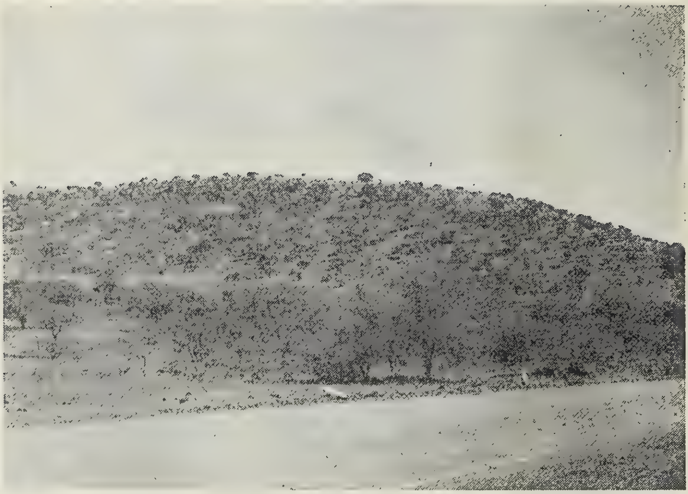

FIG. 24.

Southern slope of a quartzite hill between Koedoesfontein and Parys. On the upper slope *Acacia caffra* is the dominant tree, while *Protea caffra* occupies the lower slope. On the plain below (foreground) *Acacia karroo* is dominant.

May.

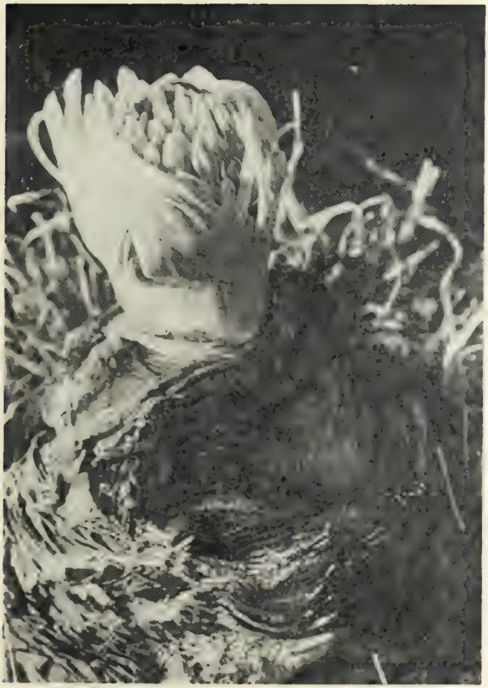

FIG. 25.

Boöphone disticha, a common grassveld species, showing part of the enormous tunicated bulb, partly buried, and the inflorescence bursting forth. The leaves are hysteranthous and appear considerably later.

October.

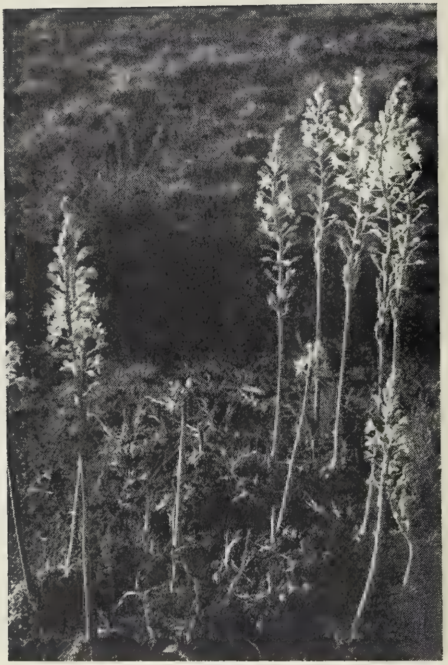

FIG. 26.

Urginea burkei: part of a small clan in Thorn Veld near Frederikstad. The leaves are just emerging from a few bulbs.

September.

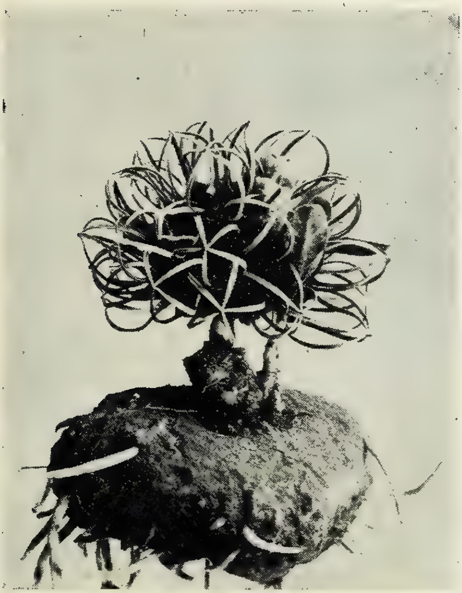

FIG. 27.

Brachystelma barberiae, a rare plant which occurs on stony ground. (About ½ natural size).

November.

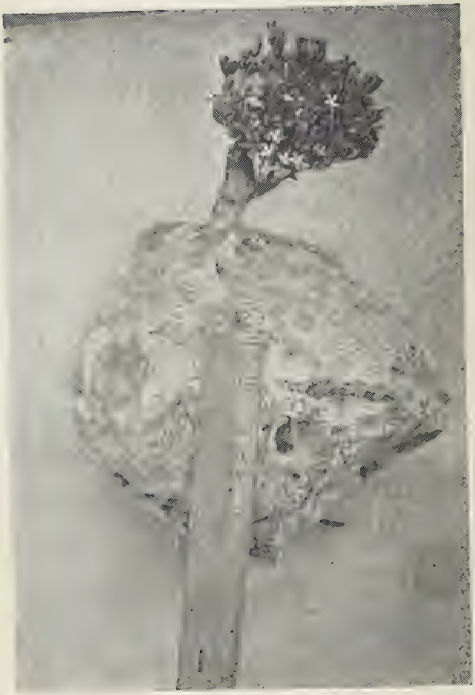

FIG. 28.
Raphionacme hirsuta.

October.

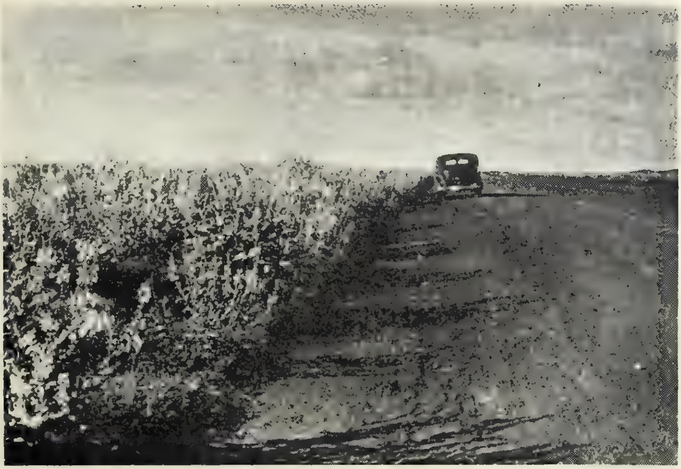

FIG. 29.
Salvia radula dominant in overstocked grassveld. Near Boskop.

November.

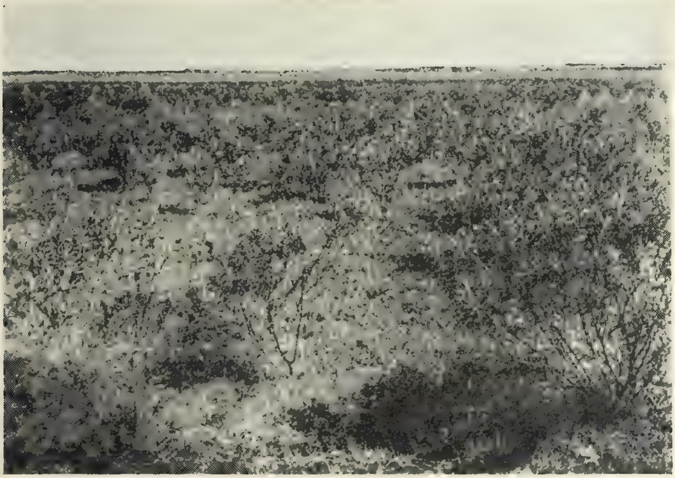

FIG. 30.
Subsere on fallow maize land, near Muiskraal: *Asclepias fruticosa* and *Cynodon dactylon* co-dominant; *Acanthospermum australe* subdominant in parts.

April.

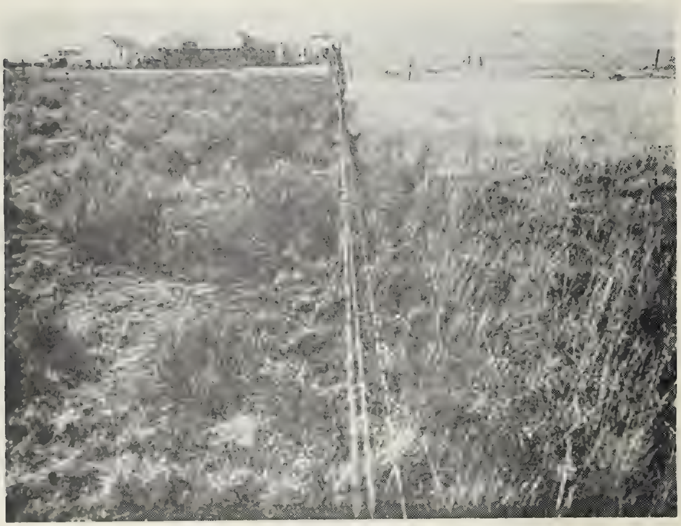

FIG. 31.

Effects of overstocking: Left, *Stoebe vulgaris* completely dominant in overgrazed area; Right, *S. vulgare* absent in protected maize camp, under closed cover of grass; mainly *Eragrostis* spp. Witpoort. *August.*

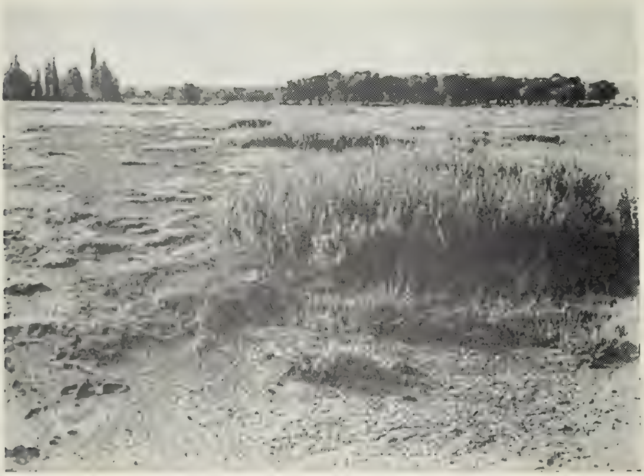

FIG. 32.

Several clumps of *Zizyphus zeyheriana* in severely trampled veld of the Potchefstroom town commonage. *Cynodon dactylon* in the foreground; also *Eragrostis lehmanniana.* In protection of the clump: *Teucrium capense*, *Delosperma herbeum*, *Mariscus rehmannianus*, *Lepidium divaricatum*, *Convolvulus ulosepalus*, *Zinnia multiflora*, none of which were found outside the clump. *January.*

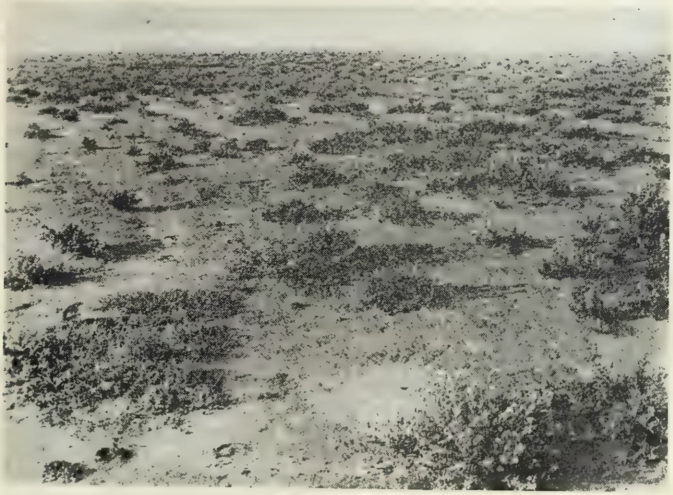

FIG. 33.

Lippia scaberrima completely dominant in overstocked veld in the Vyfhoek commonage.

March.

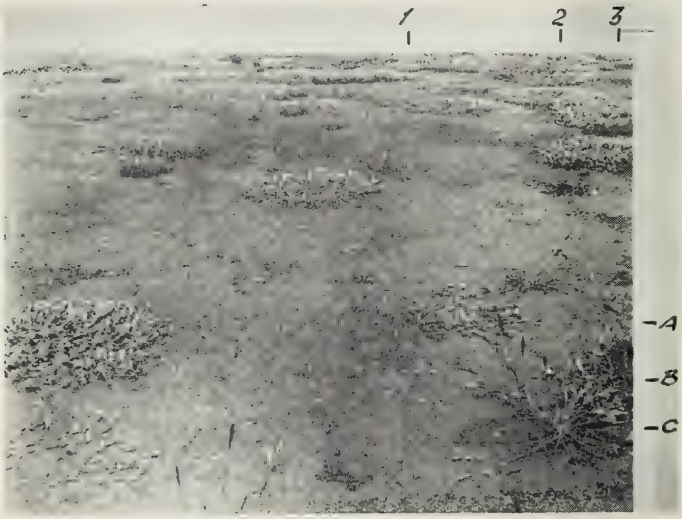

FIG. 34.

Subsere on a hockey field in Potchefstroom: The surface was topped with ant-hill soil and rolled, after which the field was in use for one season. Thereupon it was weeded once (in December) three months before this photograph was taken. It is probable that many seeds were introduced with the ant-hill soil. Ant-hills are usually surrounded by bare ground, on which such pioneers occur. 16 Species were counted, of which *Gomphrena celosioides* and *Aristida barbicollis* were best represented.

The decumbent and prostrate habits were predominant.

1 A, *Tragus berteronianus* on *Cynodon hirsutus*; 2 C, *Aristida barbicollis*; 3 B, *Urochloa helopus*; left foreground and background, *Gomphrena celosioides*.

March.

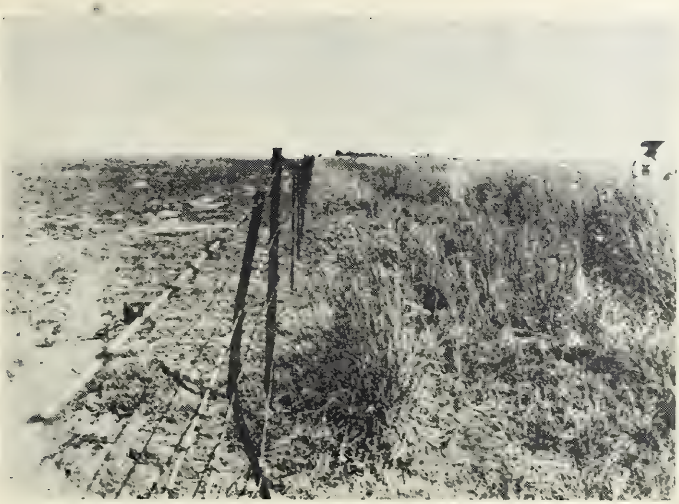

Fig. 35.

Effects of overstocking: Right, protected strip along a national road, *Hyparrhenia hirta* and *Themeda triandra* dominant; left, grazing camp. The veld is already depleted and winter, possibly also a dry spring, are still ahead.

May.

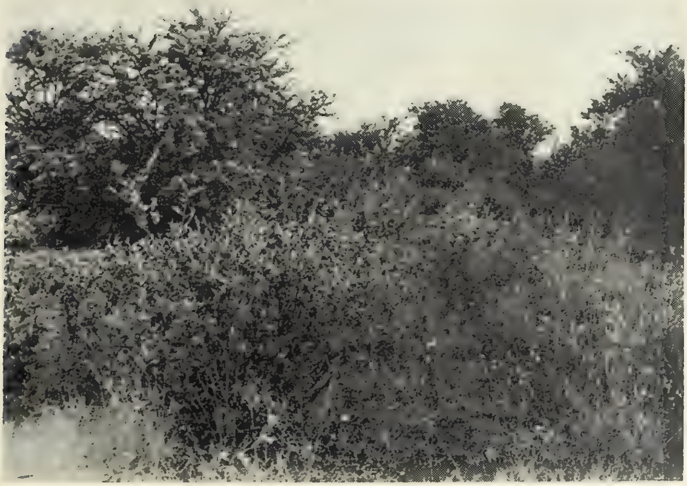

Fig. 36.

Acacia karroo—Grewia flava association. In right foreground, *Themeda triandra.*

February.

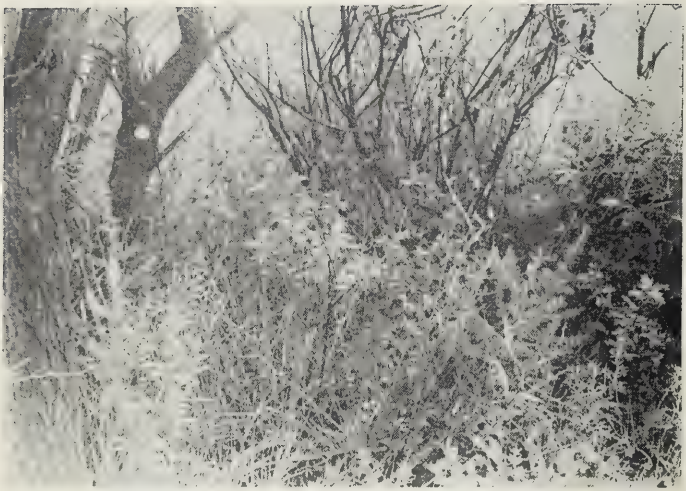

Fig. 37.

Undergrowth in Tree Veld: Trees, left, *Acacia karroo*; in background, *Grewia flava*. Foreground: *Asparagus suaveolens*, *Ceropegia crassifolia*, *Lippia scaberrima*, *Teucrium capense* etc.

February.

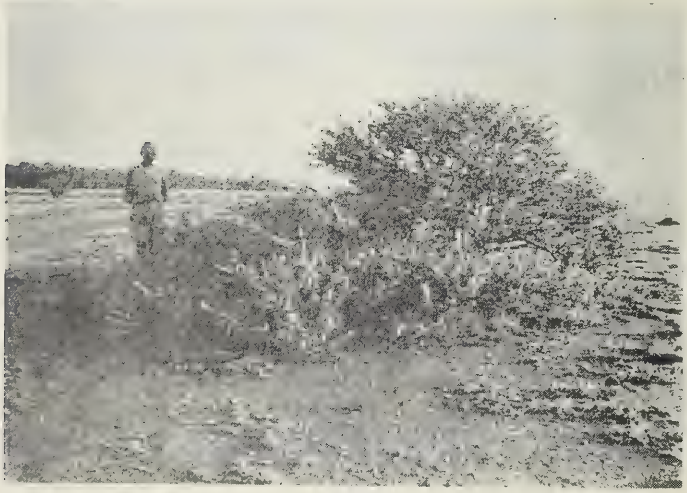

Fig. 38.

Acacia stolonifera: one branch, right, distinctly arborescent; remaining branches stoloniferous.

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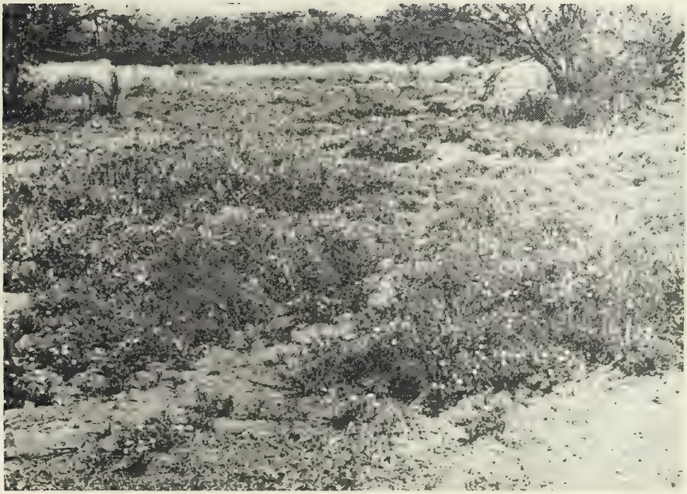
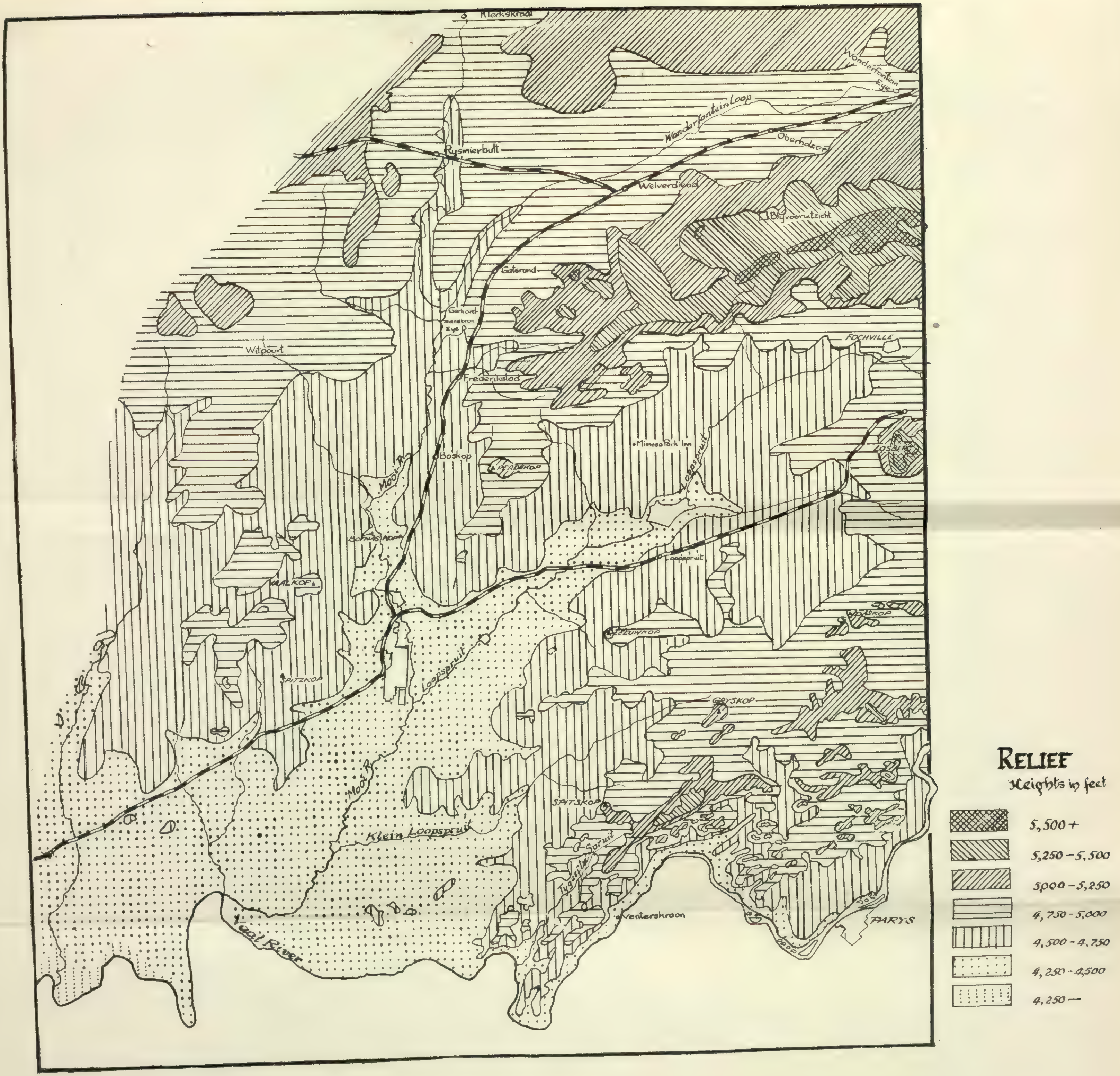


FIG. 39.
Aster muricatus, dominant undergrowth in overgrazed Tree Veld.

April.


RELIEF
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5,000 – 5,250
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4,250 —
Klerkskraal
Wonderfontein Eye
Wonderfontein Loop
Oberholzer
Rysmierbult
Welverdiend
Blyvooruitzicht
Gatsrand
Gerhard-minnebron Eye
Witpoort
Frederikstad
FOCHVILLE
Boskop
PERDEKOP
Mimosa Park Inn
Loopspruit
LOSBERG
Mooi R.
VAALKOP
LEEUWKOP
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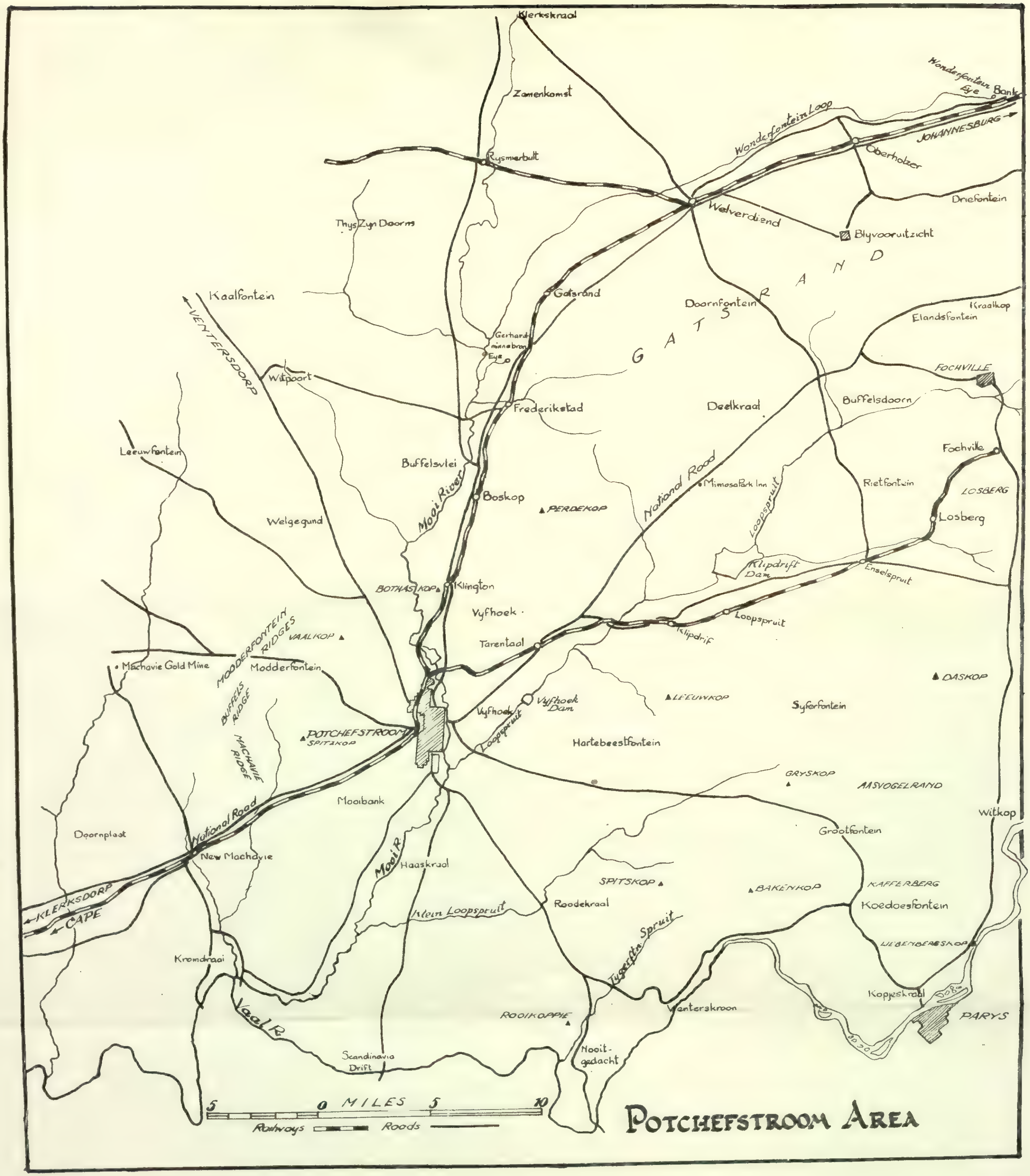
Vaal River
Ventershroon
PARYS



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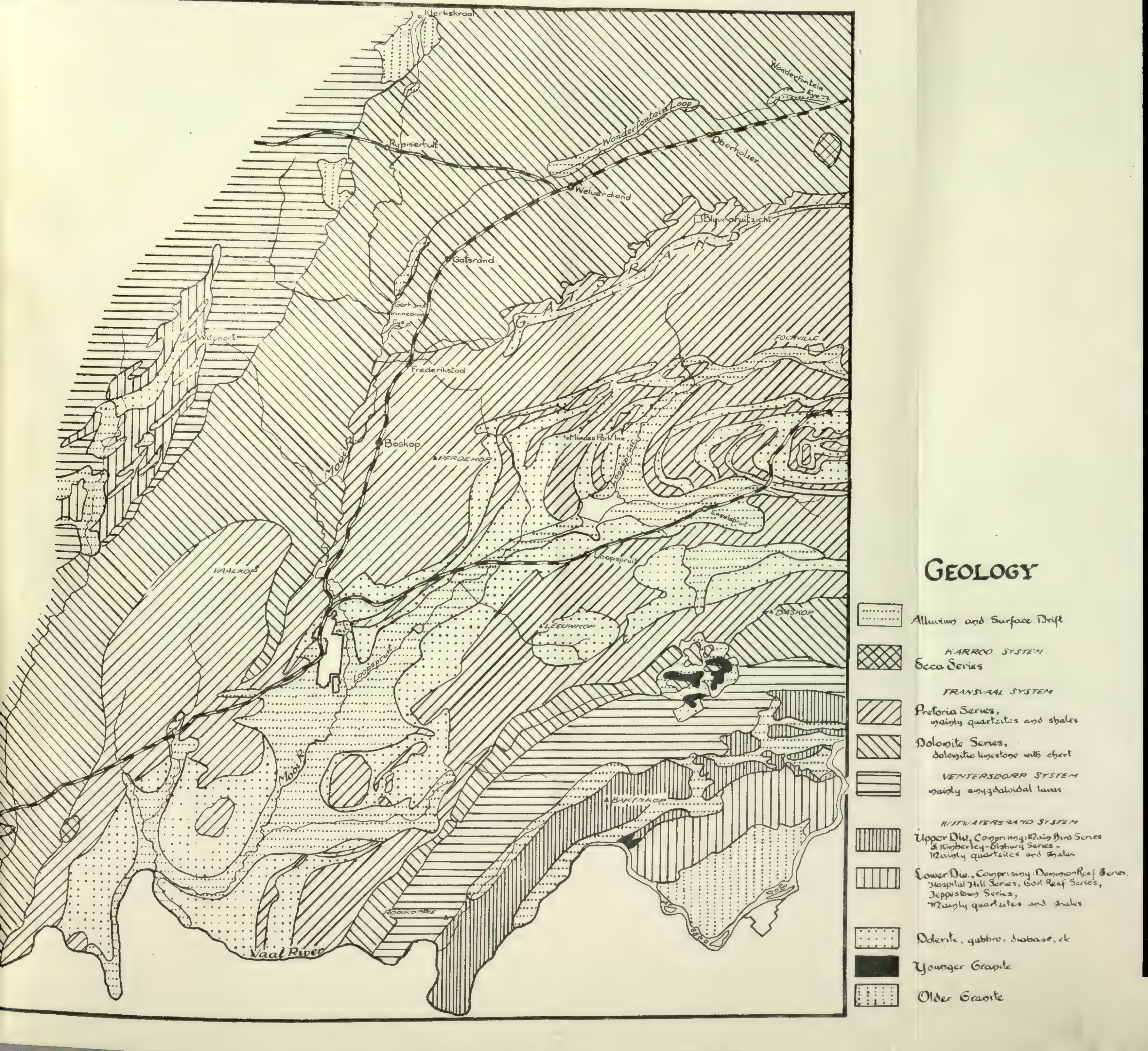

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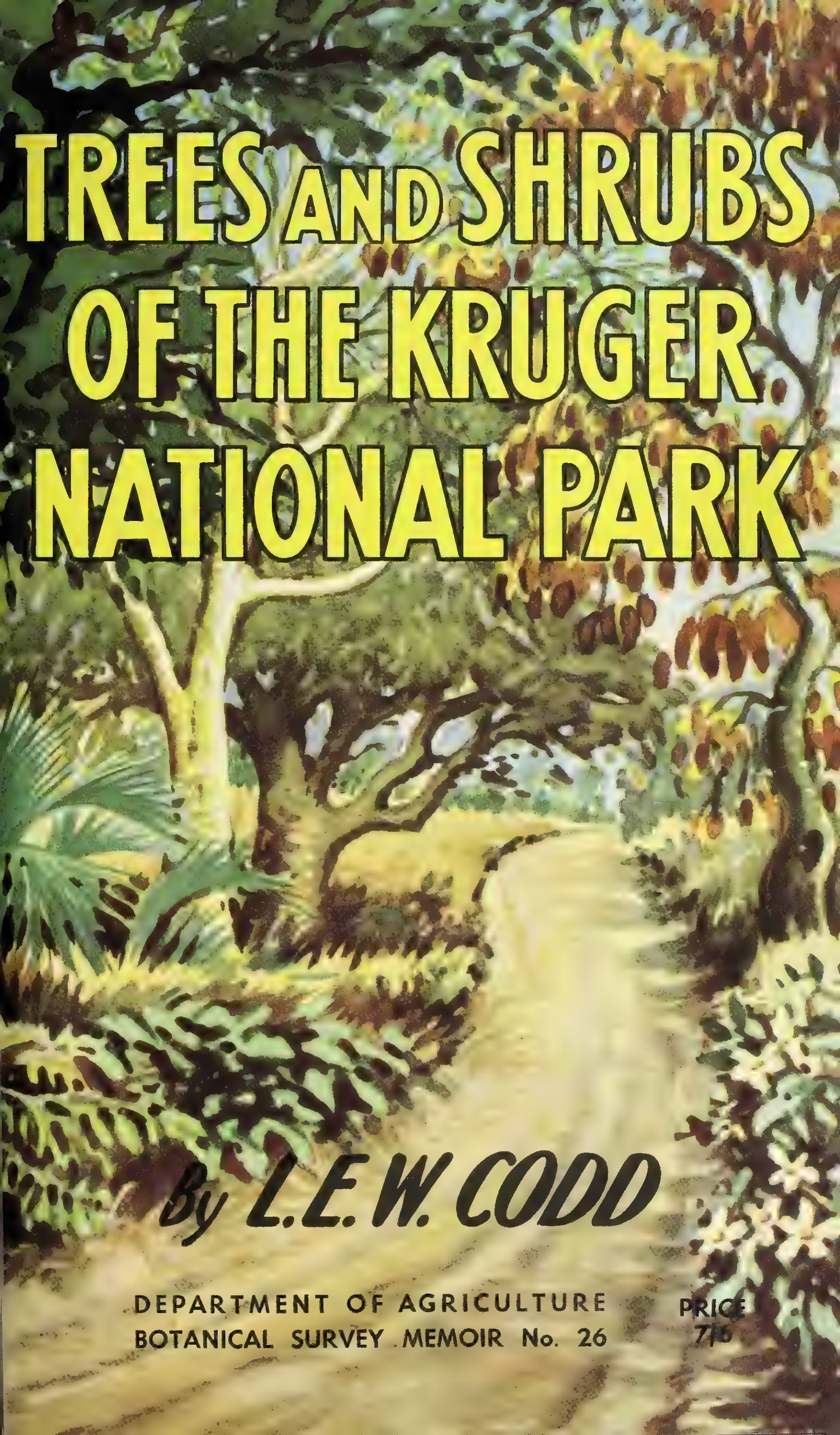

TREES AND SHRUBS OF THE KRUGER NATIONAL PARK

By L.E.W. CODD

DEPARTMENT OF AGRICULTURE
BOTANICAL SURVEY MEMOIR No. 26

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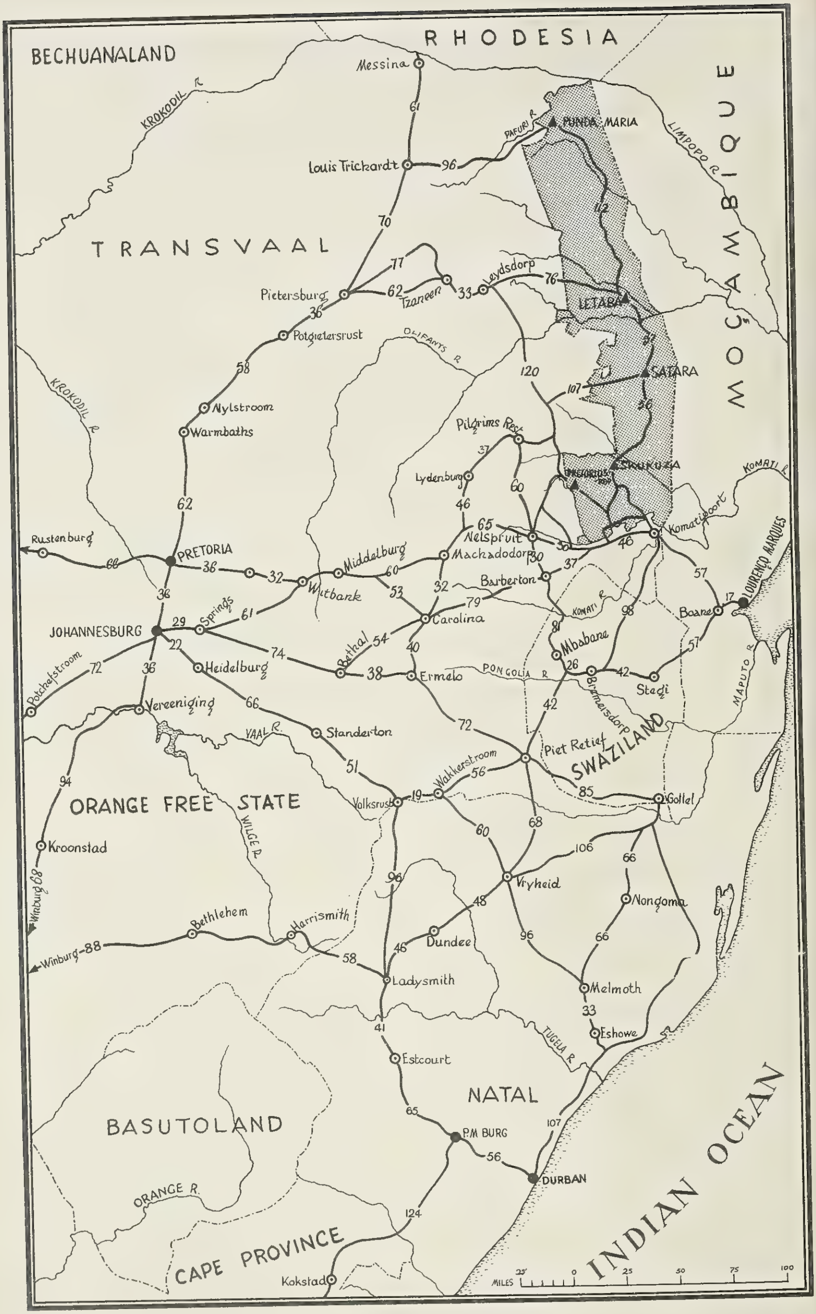
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PAFURI R.
PUNDA MARIA
LIMPOPO R.
Louis Trichardt
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Pietersburg
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Leydsdorp
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LETABA
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Potgietersrust
OLIFANTS R.
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SATARA
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UNION OF SOUTH AFRICA

DEPARTMENT OF AGRICULTURE
DIVISION OF BOTANY AND PLANT PATHOLOGY

BOTANICAL SURVEY MEMOIR NO. 26

Trees and Shrubs of the Kruger National Park

by

L. E. W. Codd, D.Sc.

Officer in Charge of Botanical Survey, Division of Botany and Plant Pathology, Pretoria, South Africa

ERRATA.

P. 13.—For *Poinciana regia* read *Delonix regia.*

Pp. 63, 64.—Following the revision by J. Leónard (Bull. Jard. Bot. Bruxelles, Vol. 19, 1949), the genus *Copaifera* is regarded as being confined to South America. Our Mopane then becomes *Colophospermum mopane* Kirk and *Copaifera conjugata* must be changed to *Guibourtia conjugata* (Bolle) J. Leónard.

P. 100.—In Fig. 96 the letters *a* and *b* should be interchanged.

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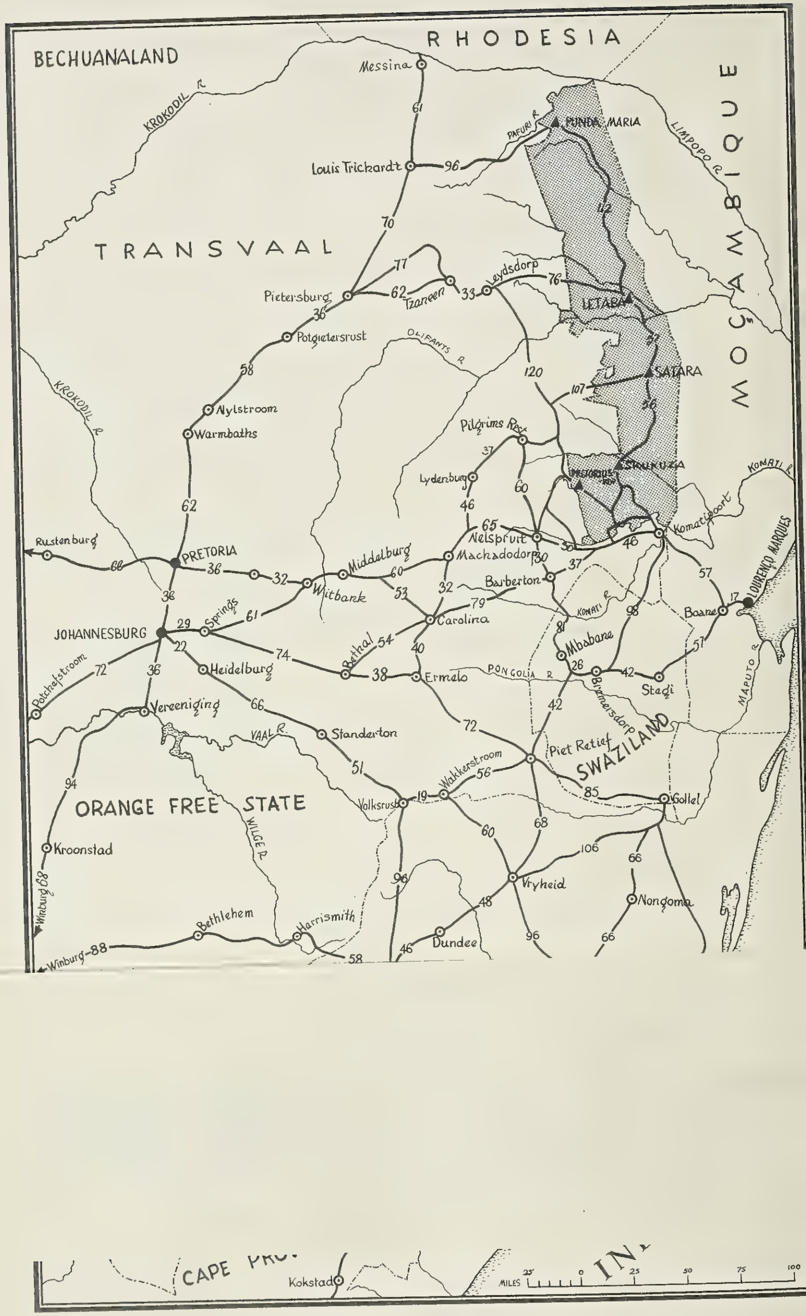
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ORANGE FREE STATE
SWAZILAND
CAPE PRO.
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PAFURI R.
OLIFANTS R.
KOMATI R.
VAAL R.
WILGE R.
PONGOLA R.
MAPUTO R.
Messina
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Pietersburg
Tzaneen
Leydsdorp
Potgietersrust
Nylstroom
Warmbaths
Pilgrims Rest
Lydenburg
Nelspruit
Machadodorp
Barberton
Komatipoort
Lourenço Marques
Boane
Rustenburg
PRETORIA
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FOREWORD.

The publication of this Botanical Survey Memoir on the Trees and Shrubs of the Kruger National Park by Dr. Codd throws new light on Botanical Survey within the Union. Most previous memoirs have been written for the scientist and student: this has a special appeal for the general public as well.

The keen interest of Dr. R. Bigalke, Director of the National Zoological Gardens and a member of the National Parks Board of Trustees, has been a strong stimulus throughout the preparation of the work and it was mainly due to him that the Board made a contribution of £200 towards its publication.

The work will bring home to many that the Park is not of interest solely for the animals it harbours. We all know that without the vegetation there would be no animals. But we may overlook this fact and we may also overlook the fact that the trees and shrubs have a beauty and interest of their own in addition to the vital role they play in the life of the animals. Trees and shrubs are permanent features and whether game is plentiful or not the trees and shrubs remain. Many have rare and unsuspected beauty and others have long been used in native customs. Dr. Codd has chosen discretely what to include and what to exclude of his profound knowledge of the vegetation of the Kruger National Park.

The South African visitor, the overseas tourist and the student will all find satisfaction in Dr. Codd's presentation of his subject. No one will know everything it reveals. Not only is the text of interest throughout, but it is supported by a wealth of illustrations, some in colour, which will guide the veriest novice and introduce the youngest enthusiast to a fascinating subject.

R. A. Dyer,
Director of the Botanical Survey
and Chief, Division of Botany
and Plant Pathology.

January, 1951.

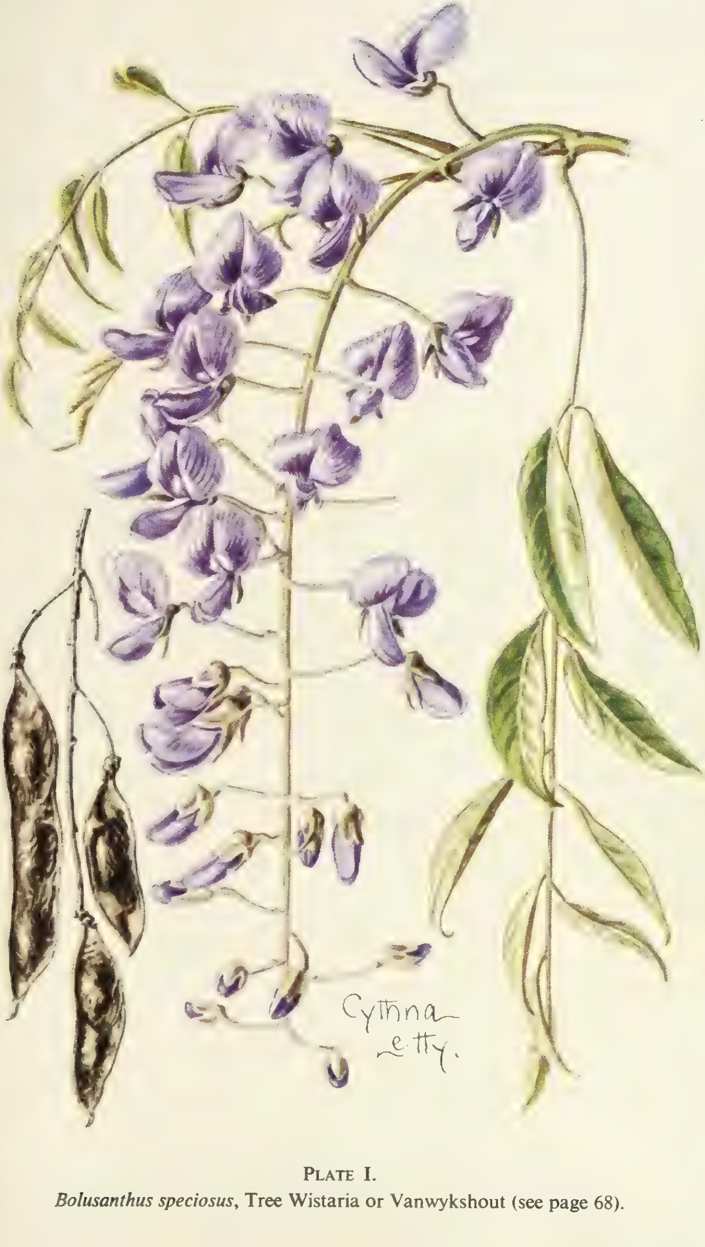

Plate I.
Bolusanthus speciosus, Tree Wistaria or Vanwykshout (see page 68).

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PREFACE.

In preparing this guide to the trees and shrubs of the Kruger National Park the object has been to answer in popular terms such questions as What trees are there in the Park? How may they be recognized? Where else do they occur? Have they any particular interest or economic uses?

Drawings and photographs have been included to assist readers in identifying the commoner and more interesting woody plants. In addition, species native to the Park are numbered in sequence in the text and corresponding numbers will be placed on conspicuous trees along roads and in rest camps.

In order to reflect the relationships of the different plants, the species are arranged in their botanical families, in the sequence of *The Genera of South African Flowering Plants* (1951) by Dr. E. P. Phillips. Properly annotated herbarium specimens have been preserved of all the species mentioned and most of them have been collected by the writer during periodic short visits to the Park over the past two years. At the same time, many other flowering plants have been collected with a view to preparing, at a later date, a more comprehensive and scientific account of the entire vegetation of the Park.

More than 1,100 different species have been recorded so far and of these, 120 species may be described as trees, 165 as shrubs (excluding a number of shrublets of less than 3 ft. high), while 36 are woody climbers.

In describing the species, the botanical name is given first followed, wherever possible, by common names as well as the native names used by the two main tribes inhabiting the Kruger National Park area: the Shangaans in the north and the Swazis in the south. Some common names are well known and have a wide application but, unfortunately, the majority of lowveld species have no accepted Afrikaans or English names.

Scientific names are essential in the classification and study of living things since they apply to one species only and, being internationally used, they do not vary from place to place. They consist of two parts, the genus and the species. The genus is given first and may be regarded as a surname, indicating the relationship, while the species name refers to the individual. For international reasons the names are, more often than not, derived from ancient Latin or Greek roots, giving them an unfamiliar appearance and often making pronunciation difficult at first sight.

Often the scientific name describes some outstanding character of the plant, for example, the Fever Tree or Sulphurbark Thorn is known as *Acacia xanthophloea,* the species name being derived from the Greek *xanthos,* yellow, and *phloeos,* bark. It frequently happens also that the species is named after a place or person. Thus the Haak-en-steek or Umbrella Thorn was named *Acacia litakunensis,* meaning the Acacia of Litakun (the old name for Kuruman), while the Red-thorn or Rooidoring is *Acacia gerrardi,* or Gerrard's Acacia, after the original collector. After the specific epithet it is customary to write the name (or abbreviation of the name) of the botanist who published the scientific name. For instance, *Acacia litakunensis* Burch. indicates that the famous traveller and naturalist Burchell was responsible for naming this species (see page 46).

Very little has been written previously on the vegetation of the Park. Colonel Stevenson Hamilton, in his book *The Lowveld, Its Wild Life and Peoples* (1929), has gathered together interesting notes and observations on some of the commoner trees and shrubs. In an appendix he gives a classified list of species but this record is not supported by a complete collection of specimens and cannot be verified. In 1937, Miss A. A. Obermeyer, at that time botanist at the Transvaal Museum, published a list of some 300 species of flowering plants and ferns collected mainly by Dr. Herbert Lang in the Kruger National Park in the early summer of 1932 (Annals of the Transvaal Museum, Vol. 17, Part 4). This carefully named collection is available for study at the Transvaal Museum and it may be noted that the majority of the species listed have again been collected during the present survey.

In preparing the descriptions and economic notes, the writer has used the specimens and records filed in the National Herbarium, Pretoria, and has also drawn freely from the following sources: —

J. Burtt Davy. *Flowering Plants and Ferns of the Transvaal and Swaziland,* Part I, 1926 and Part II, 1932.

I. C. Verdoorn: *Edible Wild Fruits of the Transvaal,* Dept. of Agr. and For. of S. Africa, Bulletin 185, 1938.

E. E. Galpin: *The Native Timber Trees of the Springbok Flats,* Botanical Survey of S. Africa, Memoir No. 7, 1924.

C. C. Stapleton: *Common Transvaal Trees,* Dept. of Agr. and For. of S. Africa, Bulletin 164, 1937.

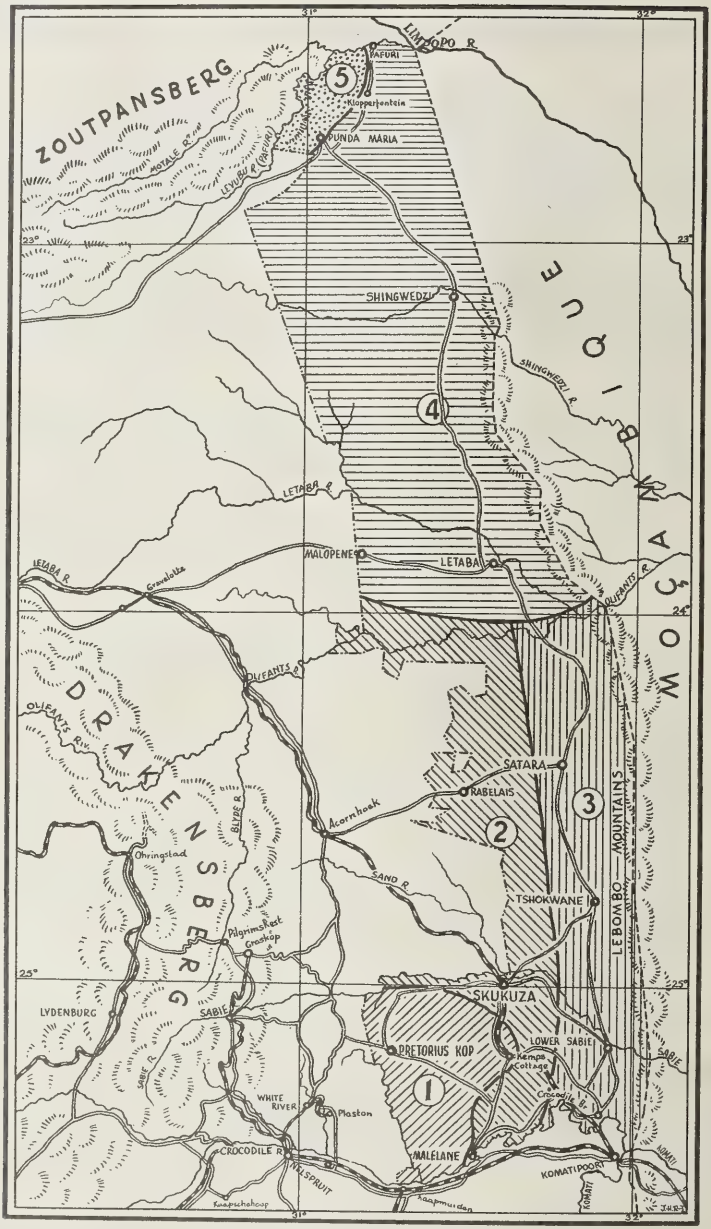
T. R. Sim: *Native Timbers of South Africa,* 1921.

J. M. Watt and M. G. Breyer-Brandwijk: *The Medicinal and Poisonous Plants of Southern Africa,* 1932.

The National Parks Board of Trustees has extended to the Division of Botany and Plant Pathology every facility for the survey and this opportunity is taken of acknowledging their help. I am personally most grateful for the close co-operation of the Warden and staff of the Park, especially in my excursions to less accessible areas.

The work has benefited by the assistance of artists who have clearly portrayed the main characteristics of the trees and shrubs, very often from dried herbarium specimens. The black and white drawings have been done, with few exceptions, by Mrs. O. M. Hilliard, previously of the National Herbarium staff, and Mr. J. H. Rose-Innes. Cythna Letty, who is well known for the beautiful illustrations of South African flowers in *Flowering Plants of Africa,* has contributed five coloured plates and and a few line drawings, while one coloured plate is by Miss M. E. Connell.

Finally I have to thank several of my colleagues in the National Herbarium for assistance in various other directions and particularly Miss E. A. Bruce for plant identifications and Miss I. C. Verdoorn for kindly reading the manuscript and for her many helpful suggestions.



Map showing the main vegetation regions of the Kruger National Park: 1. Large-leaved deciduous bush; 2. Mixed Rooibos or Red Bush-willow veld; 3. Knobthorn-Marula parkland; 4. Mopaneveld; 5. Punda Maria sandveld.

The Vegetation of the Kruger National Park

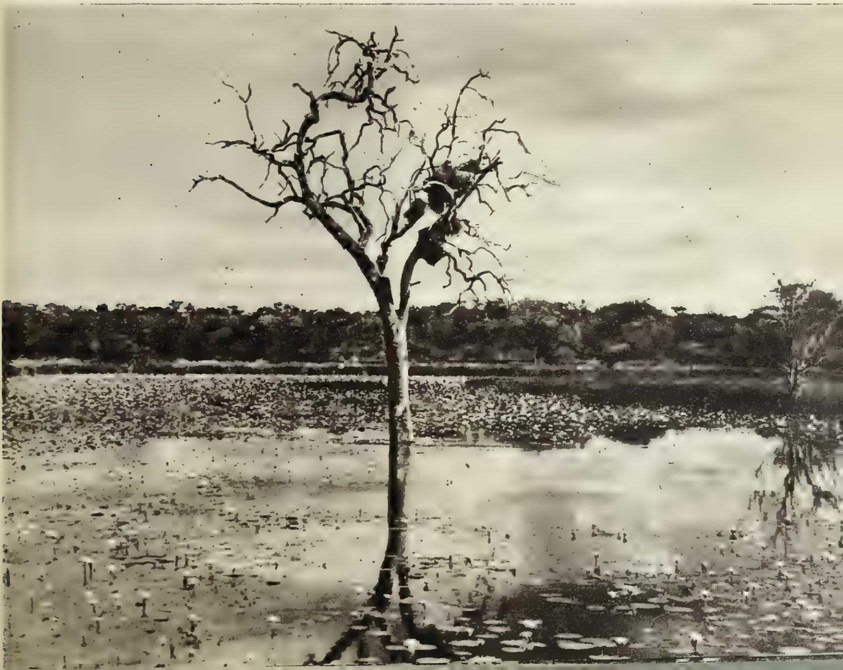
The Kruger National Park forms an oblong area of about 8,000 square miles. From the north to the south, it is about 240 miles in length, while from east to west it varies from about 25 to 50 miles in width. Its boundary in the south is the Crocodile River, in the north the Levubu (Pafuri) and Limpopo Rivers. Other important rivers flowing through the Park are the Sabi, Olifants, Letaba and Shingwedzi and their tributaries. The eastern boundary of the Park is marked by a low range of hills, the northern extension of the Lebombo Mountains, which also forms the boundary between the Transvaal and the neighbouring territory of Portuguese East Africa.

The Park is situated in the lowest part of the Transvaal, the so-called Lowveld, where the altitude varies from about 500 feet above sea level at Crocodile Bridge to slightly over 2,000 feet in the neighbourhood of Pretorius Kop. There is also an increase in altitude towards the extreme north, reaching 1,700 feet at Punda Maria.

Rainfall increases with altitude, varying from less than 15 inches per annum on the flats between the Olifants and Shingwedzi Rivers to over 30 inches around Pretorius Kop. Over 90 per cent. of the precipitation falls during the summer months of October to March and as it comes in the form of heavy thunder showers, much of it runs off without benefiting the vegetation. Temperatures vary from near freezing point in winter to well over 100° F. in the shade in summer. The frost limit is of importance as it plays a large part in checking many species in their distribution towards the cooler south and west.

The soils of the Park are derived almost entirely through weathering of the underlying parent rock and only the narrow strips of alluvium along the larger rivers can be classed as transported soils. The oldest

FIG. 1.—Lion Pan, near Tshokwane. The water-lilies are the pale blue *Nymphaea capensis* and the white *Ottelia exserta.*



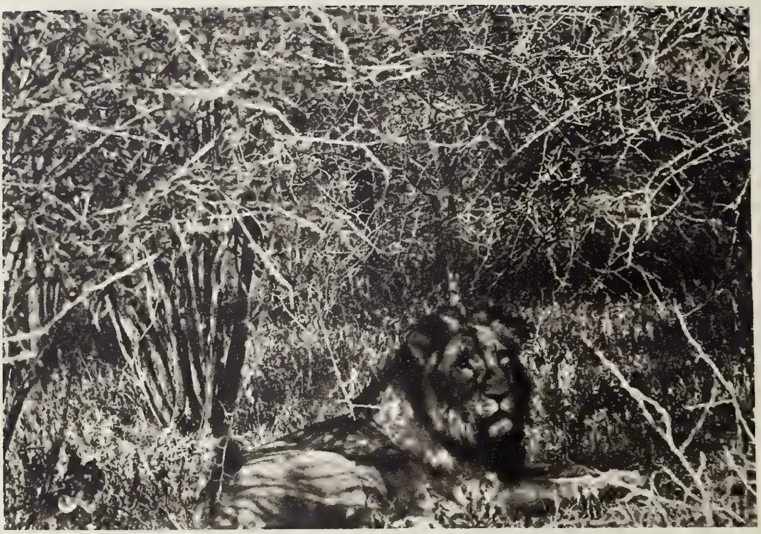


FIG. 2.—Lion in dense growth of Sickle-bush on the Lower Sabie road, near Skukuza.

geological formation is the granite, which is exposed along almost the entire western edge of the Park and is responsible for the characteristic dome-shaped koppies in the Pretorius Kop section. Under arid conditions, this rock weathers to a reddish gritty soil (region No. 2 on the accompanying vegetation map) but, with higher rainfall, the soil is more leached and has a greyish colour, though it retains its sandy or gritty texture (vegetation region No. 1).

Superimposed on the granite are three other formations. The oldest of these is the Swaziland System, which occurs in the extreme south-west and, consisting as it does of hard and erosion-resistant rocks, is responsible for the hilly country west of Malelane. At the other end of the Park, the Waterberg System, with its hard, reddish-brown quartzites and sandstones forms the ridge on which the Punda Maria Rest Camp stands and produces some very broken and rocky country, difficult of access, between Punda Maria and the Levubu River. The rocks weather to a fine whitish or pale red sand and the area occupied by this formation is separated as region No. 5 on the vegetation map.

The third and most recent geological formation, the Karoo System, occupies the entire eastern section of the Park from the Levubu River in the north to the Crocodile River in the south. The tremendous lava flows which occurred during this geological period gave rise to the Lebombo Range and the adjoining flats, where the volcanic rock has weathered to a rich red or chocolate loamy soil. The line of contact with the old granite runs roughly parallel with the Lebombo Range, about 10 to 15 miles from the range, passing just west of the Letaba and Shingwedzi Rest Camps, and is sometimes marked by a narrow strip of Karoo sandstone. Further to the west, the formation appears as occasional dykes in the granite, and Ship Mountain, on the Jock of the Bushveld road, is the result of an intrusion of this kind.

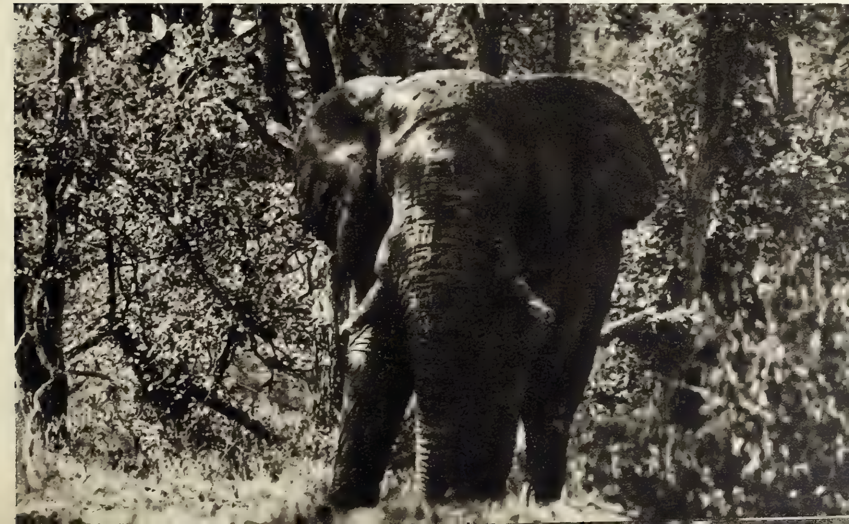
As the Park has a warm, fairly dry climate and is not isolated in any way from the lower country to the east, it is natural to find a type of bush vegetation closely related to the tropical African savannah. Probably the main line of migration southwards has been along the eastern lowland and it is noticeable that many species in the Park link up with the Zambesi valley to the north. The low lying and arid Limpopo valley has, in addition, opened up a corridor for migration from the desert savannah to the west and accounts for the fact that one repeatedly finds floral elements from Angola in the northern Transvaal lowveld. As might be expected, also, quite a large proportion of lowveld species, many of them confined to southern Africa in their distribution, are found in the neighbouring bushveld areas of higher elevation.

Having reviewed briefly the main origins of the Park's flora, it is a fascinating study to observe the extent to which the presence or absence of certain species is linked up with environmental conditions, of which the most important in the Park are rainfall and soil. If the accompanying map is referred to, it will be seen that five main vegetation regions are recognised as follows: (1) the large-leaved Combretum-Terminalia woodland (sourveld) around Pretorius Kop; (2) Red Bush-willow or Rooibos (*Combretum apiculatum*) mixed-veld stretching along the western border of the Park to the Olifants River; (3) the Knobthorn-Marula open parkland (mixed and sweetveld) running parallel with the Lebombo Range and also terminating at the Olifants River; (4) the Mopane community (sweetveld), which occupies practically the entire northern part of the Park and (5) the " sandveld " and broken country from Punda Maria north-west to the Levubu River.

Region 1 is inhabited mainly by large-leaved, thornless species and is characterised by greyish, sandy slopes and rocky koppies, while the rainfall varies from 20 inches to over 30 inches per annum. The immediate neighbourhood of Pretorius Kop is occupied by an attractive open woodland in which several fine evergreen trees are found, species that are able to grow only on river banks in the drier parts of the Park, such as the Sycomore Fig, Mkuhlu (*Trichilia emetica*), Transvaal Ebony (*Diospyros mespiliformis*) and Sausage Tree. Away from Pretorius Kop, the bush becomes denser and shorter and the main trees are various Combretums (*C. suluense, C. zeyheri* and *C. gueinzii*), the

FIG. 3.—Elephant in Mopane forest near Punda Maria.

[*Photo by H. A. Wilmar.*



Vaalboom or Silver Terminalia (*Terminalia sericea*), *Lannea discolor, Strychnos innocua, Pterocarpus rotundifolius,* Marula (*Sclerocarya caffra*) and many other deciduous species, including some attractive specimens of the Kiaat (*Pterocarpus angolensis*). The region extends eastwards to the Skukuza-Malelane road and terminates approximately at the 1,000 foot contour level. Some thorny species do occur in this region, the most conspicuous being *Acacia woodii, A. gerrardi* and *Dichrostachys nyassana.* The grasses are mostly tall and wiry, including such " sour " species as *Trachypogon capensis, Andropogon amplectens* and *Hyparrhenia dissoluta,* the last named being the chief source of thatching grass for the Park. When the game tends to concentrate on a small area, as the Blue Wildebeest in partcular has done around Pretorius Kop, these taller grasses give way to the flat-growing Kweek-grass (*Cynodon dactylon*). It is probable that this zonal overgrazing is encouraged in the early stages by grass-burning.

Region 2 occupies the reddish, granitic soils where the rainfall is less than 20 inches per annum, as far north as the Olifants River, beyond which it is replaced by the Mopane veld. The commonest species of the region is the Red Bush-willow or Rooibos (*Combretum apiculatum*), with the addition of, mainly, the Knobthorn (*Acacia nigrescens*), Marula (*Sclerocarya caffra*), *Terminalia prunioides* and the Huilbos (*Peltophorum africanum*). The grass cover is intermediate between " sour " and " sweet ", including such species as *Themeda triandra* (Redgrass), *Eragrostis superba, Schmidtia bulbosa* and *Digitaria* sp. (Fingergrass). An important variation is found on low lying, slightly brackish places and on stream banks, which are inhabited by a low thorn-scrub containing several *Acacia* species, Sekelbos (*Dichrostachys glomerata*) and several non-thorny species such as *Combretum transvaalense* (Russet Bush-willow), *Cassine schlechteri* and the Tambootie (*Spirostachys africanus*).

A variation not confined to this region is noticeable along the larger rivers where tall trees form a striking and attractive fringe of dark green vegetation. This gallery forest is largely made up of evergreen species of which the most important are the Sycomore Fig, Mkuhlu, Matumie (*Adina microcephala* var. *galpinii*), Transvaal Ebony (*Diospyros mespiliformis*), Nhlaru or Nyala Tree (*Pseudocadia zambesiaca*), Sausage Tree (*Kigelia pinnata*) and *Lonchocarpus capassa.* This type of vegeta-

FIG. 4.—Sable Antelope and Kudu near Pafuri.

[*Photo by S.A.R. & H.*

tion is seen at its best in the Pafuri Camp, where the beautiful shady trees leave a lasting impression.

Region 3 is characterised by large and well-spaced trees of the Knobthorn (*Acacia nigrescens*) and the Marula (*Sclerocarya caffra*) on the fertile, loamy flats along the eastern side of the Park, extending from the Crocodile River northwards to the Olifants River. Associated trees are the Umbrella-thorn (*Acacia heteracantha*), *Lannea kirkii* and *Lonchocarpus capassa* while, in low-lying places, it is common to find the Leadwood (*Combretum imberbe*), the Ilala Palm (*Hyphaene crinita*) with an occasional group of Fever Trees (*Acacia xanthophloea*). The Knobthorn is closely associated with the dolerite dykes which occur in the granite formation between Skukuza and Pretorius Kop, and there is always a rapid transition from Combretum-veld on the granite to Knobthorn-veld on the dolerite.

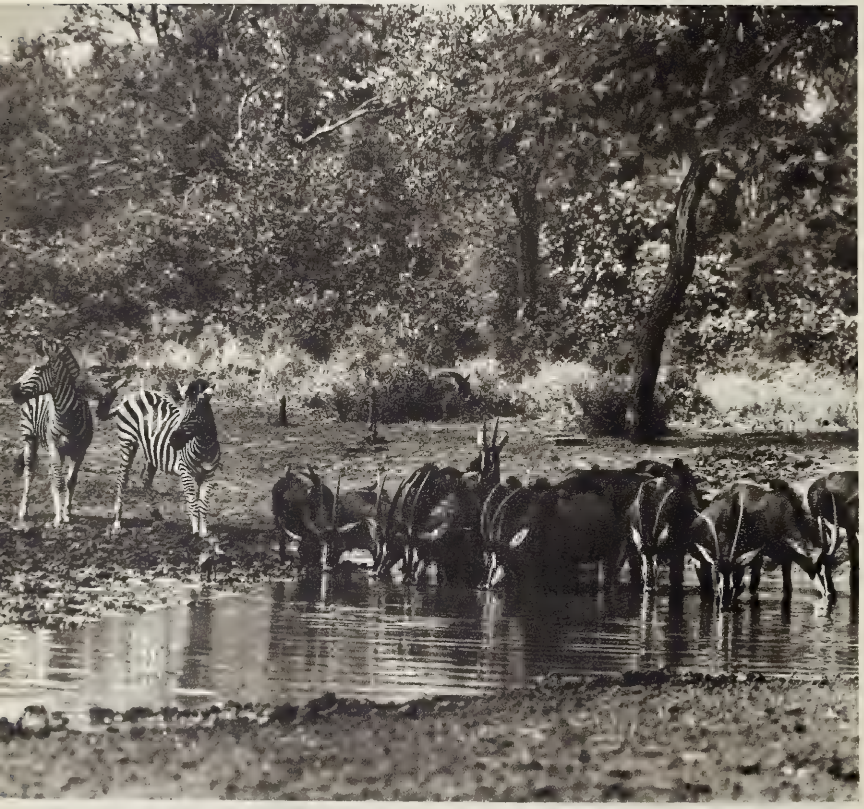
Region 4 is encountered a few miles north of the Olifants River, where the Mopane (*Copaifera mopane*) begins to dominate the landscape, occupying both the granitic soil and the Karoo formation. This species varies from a low, shrubby growth to a dense, tall, forest formation in the neighbourhood of Punda Maria. The reasons underlying these different growth forms is not understood, though the phenomenon suggests that the Mopane is extending its region of dominance. Towards Malopene in the west, the bush becomes more mixed, with a good deal of Rooibos (*Combretum apiculatum*) present. In the north, on stony slopes towards Pafuri, the graceful White Seringa (*Kirkia acuminata*) becomes more common, together with *Terminalia prunioides* and the soft-wooded Commiphoras, while the fantastic Baobabs add a striking effect to the scenery. Scattered throughout the Mopane association are odd trees of the Knobthorn, *Albizzia harveyi* and *Lonchocarpus capassa* (Mbandu) while, on low-lying places, the Leadwood and Ilala Palm are found as described in Region 3.

Region 5 occupies a small area in the extreme north-west of the Park, but is so different from any other region as to warrant separate treatment. The region is broken by ridges of Waterberg quartzite, which weathers to a white or pale red, sandy soil, often quite deep and loose. Partly for this reason, very little of the region is open to tourist traffic. Many species found on this "sandveld" are common to the

FIG. 5.—Lion family on the Lower Sabie road, near Skukuza.

central Transvaal bushveld, for example, the Wild Seringa (*Burkea africana*), *Diplorrhynchus mossambicensis* and *Pseudolachnostylis maprouneaefolia*, while fine trees of Rhodesian Mahogany (*Afzelia quanzensis*), Sycomore Fig, Transvaal Ebony (*Diospyros mespiliformis*) and *Albizzia versicolor* are more typical of the lowveld vegetation. The rocky ridges are often well wooded with the Nsimbitsi or Lebombo Ironwood (*Androstachys johnsonii*), while unusual trees, such as *Gyrocarpus americanus* and the Mountain Mahogany (*Entandrophragma caudatum*) make this one of the most fascinating regions of the Park. Added to this are species which are not found elsewhere within the borders of the Union as, for example, the "' poison vine " (*Strophanthus kombe*) and the shrubs *Holarrhena febrifuga*, *Monodora junodii* and *Cordia grandicalyx*. Between the quartzite ridges are densely wooded, sheltered kloofs, with fine trees of Matumie, Waterberry (*Syzygium cordatum*) and *Anthocleista zambesiaca* forming the nearest approach to true forest conditions found in the Park. Unfortunately, droughts and recurrent grass fires are steadily reducing the forest patches and many dead tree-trunks now remain as evidence of their extent in former times.

Fig. 6.—Zebra and Sable Antelope near Pafuri.
[*Photo by H. A. Wilmar.*



Exotic Trees and Shrubs in the Park.

In the early days of the Game Reserve, flowering trees and shrubs were planted in the rest camps for their ornamental effect and without any regard to whether they were indigenous or exotic. In recent years, young plants of indigenous trees have become more easily obtainable, and the policy now is to plant only those species which are native to the Park. Most people will agree with this policy because, not only will it give visitors an opportunity to study the indigenous flora at their leisure, but it will serve to popularise and bring into cultivation many of our little known plants.

The following is a list of exotic trees and shrubs, classified according to plant families, that have been noticed in the Kruger National Park. Most of them have been planted in Rest Camps, but some have been introduced accidentally, for instance, by the agency of rivers.

SALICACEAE.

WEEPING WILLOW, *Salix babylonica*, a native of Asia. A tree brought down by the Sabi River is growing on the river bank in the Skukuza Rest Camp.

NYCTAGINACEAE.

BOUGAINVILLEA, *Bougainvillea* spp., from South America. Woody climbers, planted in Pretorius Kop and Malelane Rest Camps for their beautiful flowers in shades of red and magenta.

LEGUMINOSAE.

BAUHINIA, *Bauhinia purpurea*, from India. A tree with white or mauve flowers, planted in Pretorius Kop Rest Camp.

BARBADOS PRIDE, *Caesalpinia pulcherrima*, from tropical America. Shrub with red and yellow, or plain yellow flowers, planted in Malelane Rest Camp.

FLAMBOYANT, *Poinciana regia*, from Madagascar. A flat-topped tree with scarlet flowers, planted in Pretorius Kop Rest Camp.

TIPUANA, *Tipuana speciosa*, from South America. A large tree with yellow flowers, planted in Pretorius Kop Rest Camp.

MELIACEAE.

SERINGA, *Melia azedarach*, from India. Tree with mauve flowers planted in Skukuza, Malelane and Crocodile Bridge Rest Camps and has established itself on a portion of the Crocodile River bank near Malelane.

EUPHORBIACEAE.

COPPER-LEAF, *Acalypha* spp., from the Pacific Islands. Shrubs with ornamental foliage, planted in Pretorius Kop Rest Camp.

CROWN-OF-THORNS, *Euphorbia splendens*, from Madagascar. Spiny shrub with red flowers planted as a low hedge in Pretorius Kop Rest Camp.

SLIPPER PLANT, *Pedilanthus tithymaloides*, from tropical America. Shrub with slender, succulent stems, planted as a short hedge in Malelane Rest Camp.

CASTOR-OIL PLANT, *Ricinus communis*, probably originally from tropical Africa. Soft shrub, scattered on river banks in the Park.

ANACARDIACEAE.

KAREE, *Rhus lancea*, a native of South Africa, but not of the Kruger National Park. Shrub or small tree, planted in Pretorius Kop Rest Camp.

MANGO, *Mangifera indica*, indigenous to tropical Asia. A few trees may be seen at Toispan, between Pretorius Kop and Skukuza.

MALVACEAE.

HIBISCUS, *Hibiscus* spp., from China. Shrubs with pink or red flowers, planted in Malelane and Pretorius Kop Rest Camps.

MYRTACEAE.

GUAVA, *Psidium guajava*, from tropical America. Small tree, growing on the Sabi River banks, brought down by the river.

GUM-TREE, *Eucalyptus* sp., from Australia. A group of large trees between Crocodile Bridge and Kemp's Cottage, said to have been planted by workmen engaged on building the railway line.

APOCYNACEAE.

FRANGIPANI, *Plumeria acutifolia*, from tropical America. Thick-stemmed shrub with waxy white and yellow flowers, sweetly scented. Planted in Pretorius Kop Rest Camp.

OLEANDER, *Nerium oleander*, from Asia Minor. Drought resistant shrubs with showy, white, pink or red flowers. The sap is poisonous. Planted in Malelane and Pretorius Kop Rest Camps.

VERBENACEAE.

LANTANA, *Lantana camara*, from tropical America. Shrub with mauve flowers, distributed by birds that eat the small, black fruits. Occurs as a garden escape near Malelane.

SOLANACEAE.

WILD TOBACCO, *Nicotiana glauca*, from South America. Slender shrub with smooth, grey leaves and cream-coloured, tubular flowers. Found on the banks of some of the larger rivers in the Park.

BIGNONIACEAE.

JACARANDA, *Jacaranda acutifolia*, from South America. Tree with attractive mauve flowers, planted in Skukuza, Pretorius Kop, Malelane and Crocodile Bridge Rest Camps.

TECOMA, *Tecoma stans*, from tropical America. Shrub with yellow flowers, planted in Punda Maria and Malelane Rest Camps.

AFRICAN TULIP-TREE, *Spathodea campanulata*, from tropical Africa. Tree with red, tulip-like flowers, planted in Pretorius Kop Rest Camp.

Notwithstanding the action taken to preserve the vegetation of the Park in its natural state, there has been a considerable infiltration of herbaceous weeds, introduced into South Africa from other countries and now widely dispersed. Some of the commoner weeds which may be noticed in the Park are: the Mexican Marigold or Khakibos (*Tagetes minuta*), Blackjack (*Bidens pilosa*), Dwarf Marigold (*Schkuhria bonariensis*), Upright and Prostrate Starburs (*Acanthospermum hispidum* and *A. australe*), Wild Zinnia (*Zinnia multiflora*), Mexican Poppy (*Argemone mexicana*), Globe Amaranth (*Gomphrena celosioides*) and Khakiweed (*Alternanthera repens*).

Indigenous Trees and Shrubs of the Park.

PALMAE. The Palm family.

Palms are found in the warmer parts of the world. In South Africa, five species occur, distributed along the eastern, coastal areas and in the northern and eastern Transvaal lowveld. Two species, the Ilala Palm (*Hyphaene crinita*) and Wild Date-palm (*Phoenix reclinata*) are to be seen in the Kruger National Park and are sufficiently distinctive to be easily recognised from the accompanying photographs.

1. **Hyphaene crinita** Gaertn. ILALA PALM: NNALA or, plural, MILALA (Shangaan); LILALA (Swazi). Fig. 7.

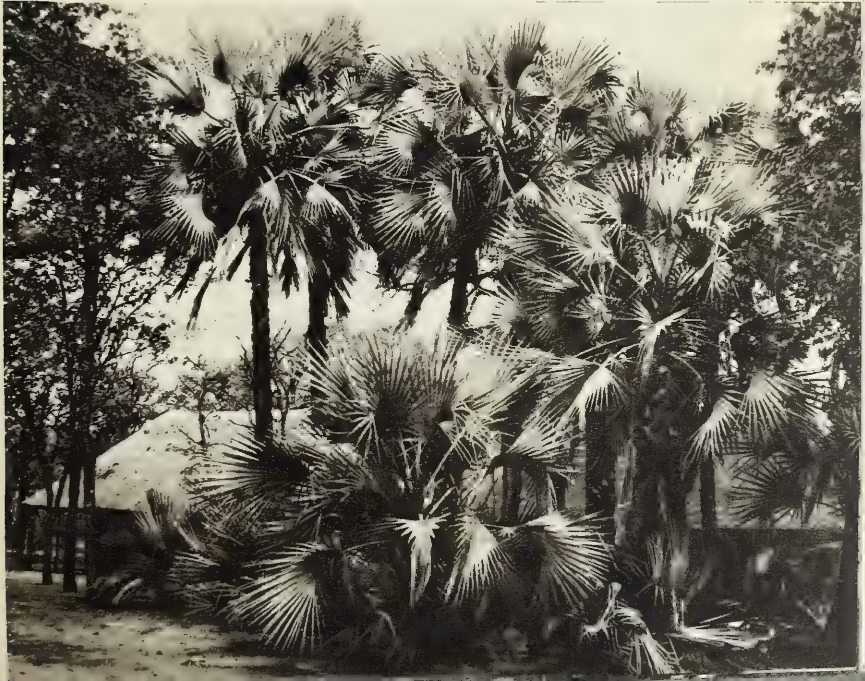
The Ilala Palm with its large, grey, fan-shaped leaves is a characteristic feature of the Park, especially in the north, in low-lying places and on river banks. It is a tropical African species, extending southwards to the north coast of Natal.

Although capable of growing to 20 or 30 feet in height, the palm is usually seen in the Park in low groups, or as solitary individuals, up to about 8 feet high. Clusters of stems are formed by the parent plant suckering from just below ground level and the accompanying photograph (Fig. 7) shows a particularly well developed group in the Shingwedzi Rest Camp. It will be noted that the bases of the old leaves adhere for the full length of the stem.

The branched inflorescences produced in the leaf axils are very conspicuous and male and female inflorescences occur on different plants. On the female inflorescence, numerous single nuts are formed, about three inches in diameter, with hard smooth shells of a dark brown colour.

FIG. 7.—*Hyphaene crinita*, the Ilala Palm, in Shingwedzi Rest Camp, surrounded by Mopane trees.

[*Photo by Dr. R. A. Dyer.*



Baboons are fond of the nuts and, in many groves near their haunts, not a single ripe nut is left on the palms.

Well-grown specimens are tapped by natives and the sap is allowed to ferment to produce an alcoholic beverage. In order to obtain this plant sap, the top of the palm tree must be removed, and stems mutilated in this way are bound to die. The palm leaves are used by natives of the tropics for thatching and mat making and also as a source of serviceable fibre for making twine. In addition, the nuts supply them with food, so the Ilala Palm is regarded as one of their most useful plants.

Colonel Stevenson Hamilton in his book *The Lowveld, its Wild Life and Peoples* (1929) mentions the *Borassus* palm as occurring in the Park, but it is thought that this statement is based on a wrong identification, as *Hyphaene* and *Borassus* have very similar leaves. A particularly fine specimen of *Borassus* is to be seen outside the Park at the roadside near Thabina, on the road from Tzaneen to Leydsdorp.

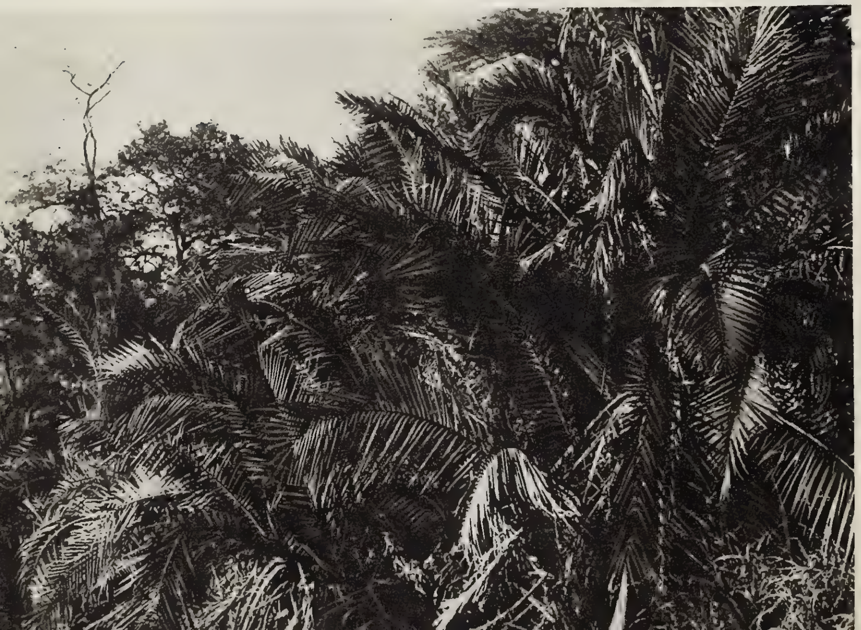
2. Phoenix reclinata Jacq. WILD DATE-PALM; LISUNDU (Swazi). Fig. 8.

The name Phoenix was given to the Date-palm of north Africa by the Greek writer Theophrastus, perhaps in reference to Phoenicia, where the Greeks were supposed first to have seen it.

The Wild Date-palm is distributed throughout tropical Africa, extending from the Nilé land in the north to eastern Cape Province in the south. It is scattered throughout the Park, usually in groups near water, the long, drooping leaves having a graceful and picturesque appearance. Although the stems may reach 12 feet in height, they are not found as tall as this in the Park, where they often occur in stemless groups, or with stems up to about 6 feet high. Some good specimens will be seen at the Eileen Orpen Dam, near Tshokwane.

The small flowers are borne in long, branched inflorescences in the axils of the leaves, the male and female flowers occurring on different plants.

FIG. 8.—*Phoenix reclinata*, the Wild Date-palm, on a stream bank between Punda Maria and Shingwedzi.



The date-like fruits are orange in colour when ripe and consist of a large, hard seed with a thin, edible, fleshy covering, much inferior both in quality and quantity to the north African Date-palm, *Phoenix dactylifera.*

LILIACEAE. Lily and Aloe family.

There are several species of Aloe in the Kruger National Park and three of them may be described as reaching shrub or tree stature with well developed stems. These three are dealt with briefly below. They are beautifully illustrated in *The Aloes of South Africa* by Mr. G. W. Reynolds.

3. **Aloe marlothii** Berger. MHANGA (Shangaan). Fig. 9.

This tall species produces a single stem which may reach a height of 10 or 12 feet. It is frequently conspicuous on dry, rocky situations in the Transvaal, often dominating the landscape but in the Park it is not common, and is found chiefly near the Sabi River.

It is as well to remember that there are several species of *Aloe* in other parts of South Africa which have a similar growth form. Two of these species could easily be confused with *A. marlothii,* namely, *A. spectabilis* of the Tugela Valley and *A. ferox* of the eastern Cape Province (the latter being the species commonly used for extracting the "aloes" of commerce). From these, *A. marlothii* is distinguished by its horizontally spreading flowering branches. The leaves of *A. marlothii* are armed along the margins with hard, recurved teeth, while both the upper and lower leaf surfaces, particularly the latter, have scattered prickles.

4. **Aloe rubrolutea** Schinz.

This Aloe occurs in the extreme north of the Park, on rocky ridges adjoining the Portuguese border in the Pafuri area. The stems are unbranched, usually from 3 to 5 feet in height, and terminate in a rosette of glaucous leaves. Strong teeth occur along the leaf margins, but the upper and lower leaf surfaces are unarmed. The inflorescence branches to form many erect, red-flowered racemes. The plants in the Park probably represent the easternmost limit of the species, which is distributed from South West Africa, through Bechuanaland to the northern Transvaal.

5. **Aloe sessiliflora** Pole Evans.

FIG. 10.

The stem of this Aloe is usually short, but may be up to 4 or 5 feet in height, and it rarely branches. It inhabits dry, rocky situations from northern Zululand to northern Transvaal and is common on the bare, granite koppies around Pretorius Kop. The individual flowers are small, yellowish in colour, and are closely packed in long, slender inflorescences. The leaves are green in summer, developing reddish tints in winter, and are softly toothed along the margins.

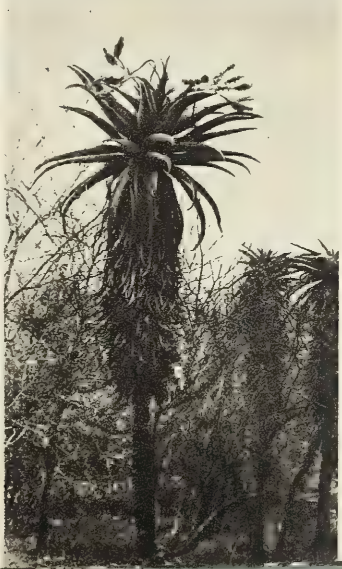


FIG. 9.—*Aloe marlothii,* near Skukuza.

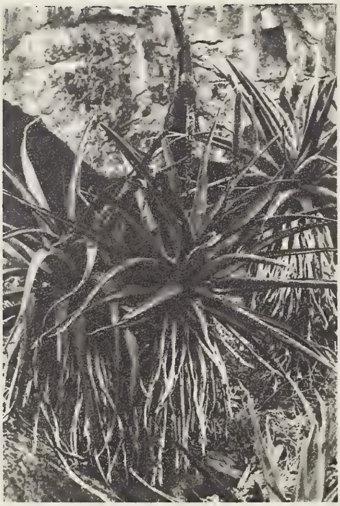


FIG. 10.—*Aloe sessiliflora,* at Eileen Orpen Dam, near Tshokwane.

SALICACEAE. The Willow family.

Probably the best known member of the family is the Weeping Willow (*Salix babylonica*), which is a native of Asia, but is widely planted in South Africa. A solitary tree of this species is growing on the bank of the Sabi River, in the Skukuza Rest Camp, having been brought into the Park by the river. In South Africa there are several species of wild willow, one of which occurs naturally in the Kruger National Park. They do not grow as large as the Weeping Willow, nor do the branches usually " weep "

6. Salix woodii Seem. NATAL WILLOW.

The species is named in honour of Dr. John Medley Wood (1827-1915) who was, for many years, Director of the Natal Herbarium, Durban. It is common along streams in Natal and, in the Transvaal, occurs in the drainage basins of the Limpopo, Olifants and Komati Rivers. In the Kruger National Park, the Natal Willow is found along perennial rivers, especially on the banks and islands of the Sabi and Crocodile Rivers, where it grows to 8 or 10 feet high with slender branches, which tend to droop slightly in the case of taller specimens.

The leaves are long and narrow, up to 3 inches long and less than ½ an inch wide, light green on the upper surface and tending to be greyish underneath. There are fine teeth, distantly spaced, along the margins of the leaves.

The flowers are in small catkins, male and female flowers occurring on different trees. The small fruits burst open, exposing a number of seeds clothed with silky, white, tangled hairs. Branches bearing many ripe female catkins look as if they are covered in cotton-wool.

Like the Weeping Willow, the leaves and young twigs of the South African species are browsed by livestock and wild animals, providing a useful source of fodder in early spring before the grass is green.

ULMACEAE. The Elm family.

7. Celtis kraussiana Bernh. CAMDEBOO- OR WHITE-STINKWOOD.

This is the best known member of the Elm family indigenous in South Africa and is a deciduous, ornamental tree with a smooth, grey trunk and a round, densely leafy crown. It has a wide distribution, occurring from Uganda, through tropical East Africa and as far south as eastern Cape Province, but is rare in the Park, having been encountered on Ship Mountain and other rocky situations to the south.

The inconspicuous flowers are produced in small clusters in early spring, together with the young leaves. The small, round fruits, which are borne on inch-long, very slender stalks, are up to ¼ of an inch in diameter, and have a thin fleshy covering. They appear to be attractive to birds, and the seeds are mainly distributed in this way.

The wood is said to be " light in weight, creamy white in colour rather woolly in texture, is used for yokes and also for wagon-tent bows, as it has a long fibre and, if soaked in water, can be easily bent ". (Stapleton, 1937). This probably accounts for the fact that many fine White-stinkwood trees are still to be seen, while more valuable timber-producing trees have been destroyed. The White-stinkwood is not related to the true Stinkwood, *Ocotea bullata*.

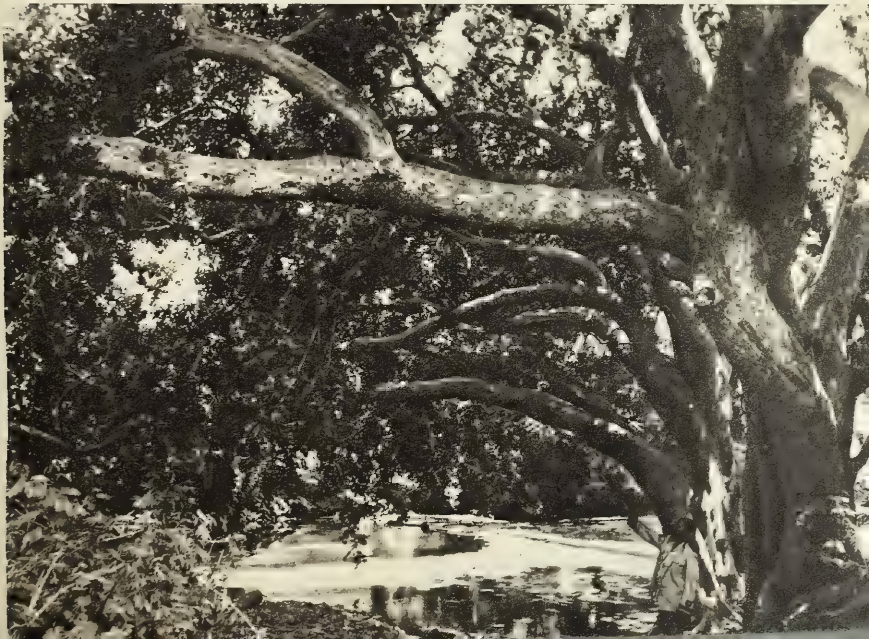
8. Chaetacme aristata Planch.

This species also belongs to the Elm family and is a spiny shrub or small tree. It is usually an inconspicuous plant and has been found scattered in fairly dense bush along river banks in the southern part of the Park.

MORACEAE. Mulberry and fig family.

By far the most numerous members of this family are the wild figs, which are classified as species of *Ficus* (the ancient Latin name for the fig). There are over 800 species of *Ficus*, spread throughout the tropics and sub-tropics of both hemispheres, about 20 species being found in South Africa. Of these, 10 have been recorded with certainty in the Kruger National Park and it is possible that additional species will be found with a more detailed botanical survey of the Park.

FIG. 11.—*Ficus sycomorus*, Sycomore Fig, on the banks of the Levubu River, near Pafuri. A bush of *Acacia pennata* is in the left foreground.
[*Photo by Dr. R. A. Dyer.*



The fruits of most wild figs, though edible, are smaller and much less attractive than those of the cultivated fig (*Ficus carica*), but they are much sought after by monkeys and many kinds of birds. In all species, the fruit has the same structure as the cultivated fig, consisting of numerous small male and female flowers on the inside of a fleshy, pear-shaped receptacle. There is a small pore at the apex of the fruit through which insects enter and pollinate the flowers.

Wild figs of the Park may be separated into two main groups according to the position of the fruits. In one group (which includes *Ficus capensis, F. gossweileri* and *F. sycomorus*) the fruits are produced in special branched clusters on the trunk and main lateral branches (see Figs. 12 and 17). In the other group, the fruits are borne on the terminal branchlets, in the axils of the leaves (e.g., *F. capreaefolia, F. ingens, F. petersii, F. smutsii, F. soldanella, F. sonderi* and *F. stuhlmannii*).

Another method of classifying them is on their growth form and ecological characters, which show striking differences. Thus, some species start growth in the fork of a " host " tree, sending down aerial roots which grow and join together, thickening with age and eventually surrounding and strangling the unfortunate host (Fig. 13). Others show a tendency to grow on rocky koppies, their roots finding almost imperceptible crevices in the bare rock surfaces (Fig. 14). Then thirdly, one finds species which grow as ordinary trees or shrubs. Classified in this way, the wild figs of the Park may be grouped as follows:

Stranglers: *F. petersii, F. stuhlmannii* and *F. gossweileri.* It should be noted, however, that these species do appear to grow sometimes as ordinary trees, without the assistance of host trees.

Rock-splitters: *F. soldanella, F. sonderi* and *F. smutsii.*

Ordinary trees and shrubs: *F. capreaefolia* (a shrub) and *F. capensis, F. ingens* and *F. sycomorus* (trees).

If the above characteristics are observed and taken in conjunction with the leaf illustrations and notes on each species, which are dealt with in alphabetical order below, it should be possible to identify the commoner species of wild fig in the Park.

9. **Ficus capensis** Thunb. CAPE WILD-FIG; NKUWA (Shangaan). Fig. 16a.

This is a deciduous tree growing around Pretorius Kop in open woodland and reaching a height of about 30 feet. In the forests of Natal and eastern Cape Province, the same species may attain to 80 feet in height, with a trunk diameter of 4 feet. The large fruits, which are greedily eaten by birds and monkeys, are borne in branched clusters on the main branches, resembling the Sycomore fig (*F. sycomorus*) in this respect. The greyish trunk and smooth leaves distinguish it from *F. sycomorus*, which has a yellowish trunk and rough leaves. The wood of the Cape Wild-fig is white and soft and of little value except for brake blocks.

10. Ficus capreaefolia Del. WILLOW WILD-FIG; PHALAVURHA (Shangaan). Fig. 16e.

Translated literally the native name means the "bow smoother", the rough leaves being used as a sandpaper to finish bows.

This species is a shrub, growing associated with reeds along the river banks, and sending up numerous thin, whip-like stems 3 to 6 feet long (up to 10 feet long along the Levubu river) with long-oblong, dark green, rough leaves. The fruits are borne in the axils of the leaves on quite long stalks and do not appear to be eaten. The species also occurs from Upper Guinea and the Nile Land to Portuguese East Africa and northern Zululand.

11. Ficus gossweileri Hutch. ANGOLA WILD-FIG; HLAPFU (Shangaan). Figs. 12 and 16b.

This interesting species, known previously only from Angola, has recently been collected on rocky, wooded hillsides in the Punda Maria area. The only numbered tree in the Park is in the Punda Maria Rest Camp grounds, near the office, and will be recognised by the fruits being borne in ones and twos on the main trunks. The species is named in honour of J. Gossweiler, the well-known botanist of Angola, who first collected it.

12. Ficus ingens Miq. Fig. 16c.

A widespread species in South Africa, often found clinging to rock-faces in the cooler parts of the country while, in the Lowveld and in tropical Africa, it is capable of developing into a large tree. In the Kruger National Park, both growth forms have been encountered, but it is a relatively rare species and is not seen from any of the tourist routes. For instance, round Punda Maria it grows into a small tree of 15 feet high while, on Ship Mountain and on granite koppies near Pretorius Kop, it is found spreading against steep rock surfaces. It is deciduous and the young leaves in spring have a bright red colour. The leaves are similar in shape to the well known Wonderboom (*Ficus pretoriae*), but the fruits are

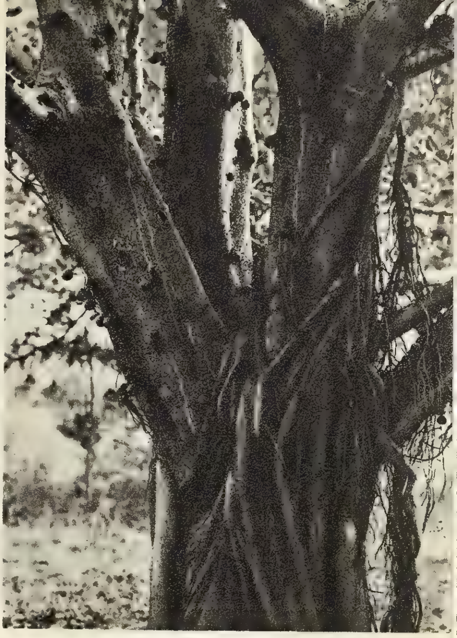
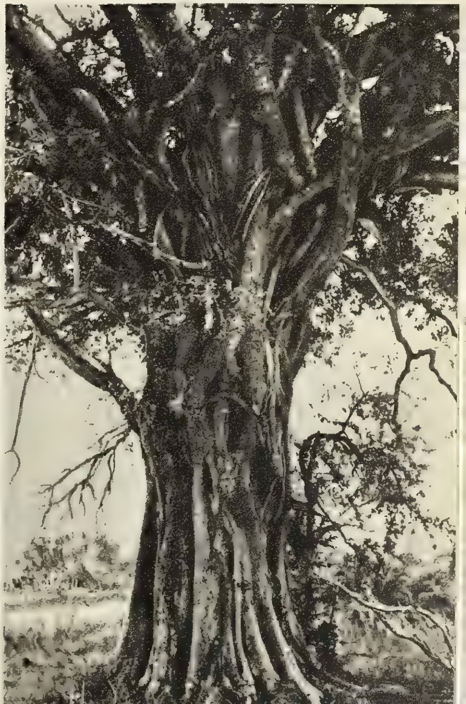


FIG. 12.—*Ficus gossweileri,* Angola Wild-fig, in the Punda Maria area.
[*Photo by Dr. R. A. Dyer.*

FIG. 13.—*Ficus petersii,* Peters' Wild-fig, strangling a Leadwood (*Combretum imberbe*) near Crocodile Bridge.



a good deal larger though, like that species, the fruits are borne in the leaf axils of the terminal branchlets.

13. Ficus petersii Warb. PETERS' WILD-FIG. Figs. 13 and 16j.

The species commemorates Professor Wilhelm Peters of Berlin, who travelled in Mocambique in the middle of the nineteenth century, and collected a large numbers of plants. It occurs in Angola, Tanganyika, Nyasaland and, southwards, to Bechuanaland, South West Africa, the Transvaal and Natal. In the Kruger National Park, it is found chiefly south of the Sabi River, some fine specimens being seen on the road from Crocodile Bridge to Pretorius Kop and, again, between Pretorius Kop and Skukuza.

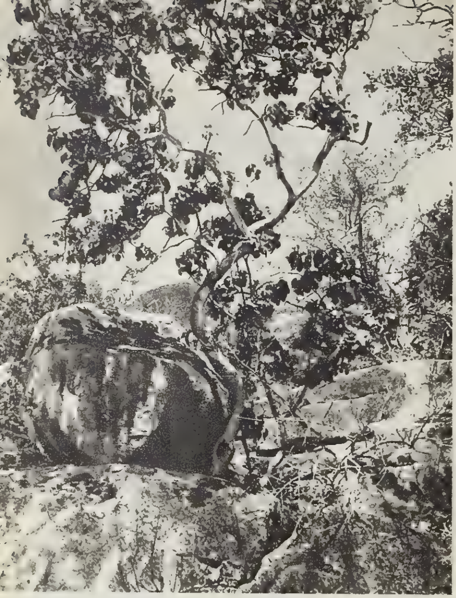


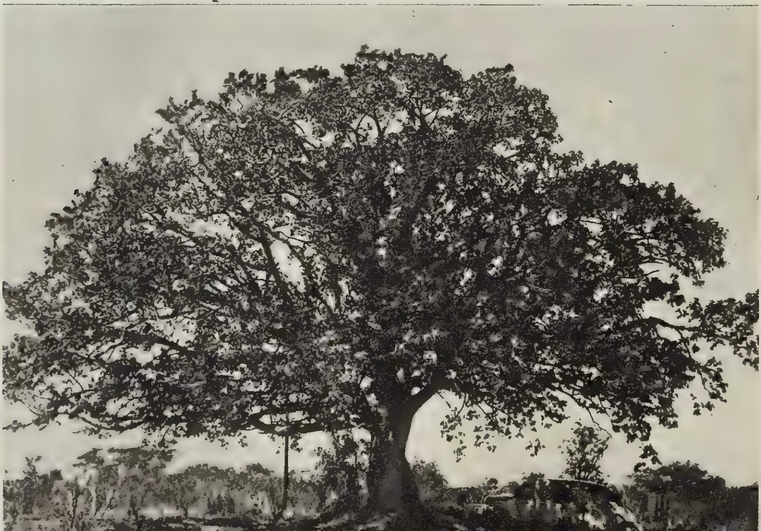
FIG. 14.—*Ficus soldanella*, Rock Wild-fig, on a granite koppie between Skukuza and Tshokwane.

It occurs as a "strangler" and as an ordinary tree. The dark green leaves are oval in shape with long, slender petioles (leaf-stalks) and are shed for a short time in winter. The leaves are quite smooth, which distinguishes *F. petersii* from the other common strangling fig, *F. stuhlmannii*. The sessile (stalkless) fruits are ¼ to ½ an inch in diameter and are borne in the leaf axils on terminal branchlets.

14. Ficus smutsii Verdoorn. SMUTS' WILD-FIG. Fig. 16h.

This species is named in honour of the late General J. C. Smuts, who first collected it along the Magalakwin River. It has since been found in rocky situations in the Limpopo River valley and extends to the northern part of the Kruger National Park. It has a twisted, whitish trunk,

FIG. 15.—*Ficus sycomorus*, Sycomore Fig, near Pretorius Kop Rest Camp. It was under this tree that Ranger Wolhuter pitched his camp in the early days of the Park.



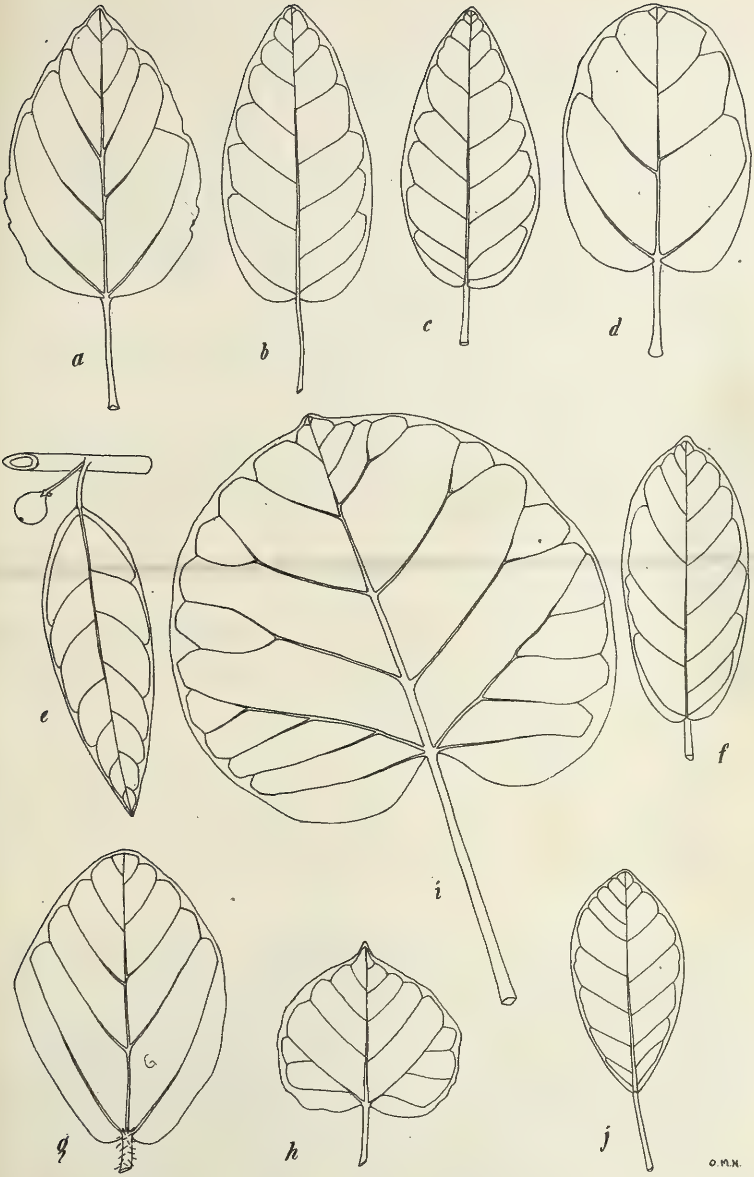


FIG. 16.—Leaves of Wild-figs, ½ natural size: a, *Ficus capensis,* Cape Wild-fig; b, *F. gossweileri,* Angola Wild-fig; c, *F. ingens;* d, *F. sonderi,* Sonder's Wild-fig; e, *F. capreaefolia,* Willow Wild-fig; f, *F. stuhlmannii,* Stuhlmann's Wild-fig; g, *F. sycomorus,* Sycomore Fig; h, *F. smutsii,* Smuts' Wild-fig; i, *F. soldanella,* Rock Wild-fig; j, *F. petersii,* Peters' Wild-fig.

which often grows almost miraculously out of the narrowest crevices in practically bare granite rock surfaces. The leaves are broader than long, somewhat kidney-shaped and are roughly hairy, in contrast with the following species, which has larger, smooth leaves.

15. **Ficus soldanella** Warb. ROCK WILD-FIG. Figs. 14 and 16i.

This is a species which occurs on rocky koppies throughout the Park, rarely exceeding 15 feet in height, with a white, usually twisted trunk. A particularly large specimen will be seen near the Malelane Rest Camp and it appears to be growing away from any rocky out-crop, but a closer examination shows a rock formation just below the soil surface. The species also occurs in Rhodesia, Portuguese East Africa and northern Natal, and is common on the Zoutpansberg, Waterberg and Magaliesberg ranges in the Transvaal.

The large, heart-shaped leaves are completely smooth and the medium-sized fruits are produced in leaf axils on the terminal branchlets.

16. **Ficus sonderi** Miq. SONDER'S WILD-FIG. Fig. 16d.

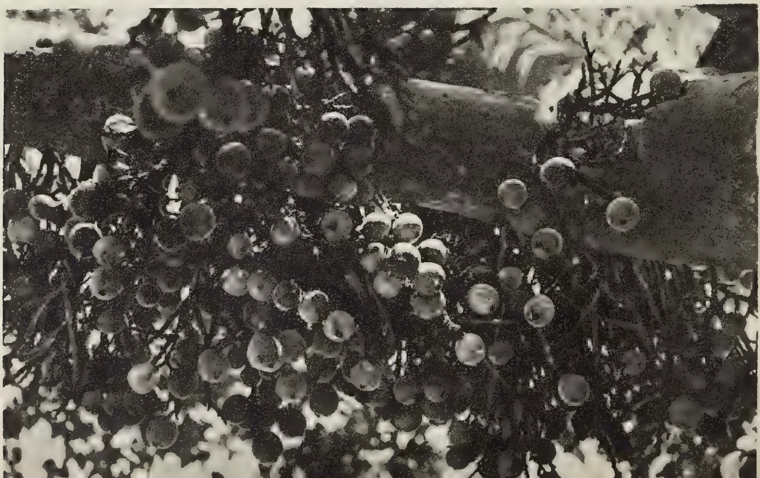
Named in honour of Professor O. W. Sonder who worked extensively on the botany of South African plants. It is found on rocky koppies south of the Sabi River and grows into a fine spreading, deciduous tree. It has oblong-oval leaves, rounded at the tip and the leaves and twigs are hairy. The fruits are relatively small and are produced in leaf axils of the terminal branchlets.

17. **Ficus stuhlmannii** Warb. STUHLMANN'S WILD-FIG; SHIRHOMBERHOMBE (Shangaan). Fig. 16f.

The species is named after Dr. Franz Stuhlmann, German botanical explorer in East and Central Africa towards the end of the nineteenth century, and is found from Tanganyika and the Belgian Congo southwards to Zululand.

It grows to a height of 30 feet and the leaves are shed for a short time in spring. Although usually found as a " strangler ", it appears to be capable of developing also as a separate tree, without any obvious aerial roots. The rough, oblong, dark green leaves make this a conspicuous tree in the deciduous woodland southwards from Satara, while a few specimens have been found away from the tourist routes in the Punda Maria area. The grey trunk is noticeably ribbed and fluted and the small fruits, borne on terminal branches, are eaten by birds.

FIG. 17.—*Ficus sycomorus,* Sycomore Fig, showing the fruiting branches.



18. Ficus sycomorus L. Sycomore Fig; Nkuwa (Shangaan). Figs. 15, 16g and 17.

The Sycomore Fig is one of the largest and most striking trees of the Lowveld, occuring chiefly on river banks, though it extends to the open woodland on sandy slopes around Pretorius Kop and Punda Maria. It reaches its greatest height of 80 feet or more along the Levubu River, in the extreme north of the Park. The tree is irregularly deciduous, some trees being found shedding their leaves towards the end of winter, while others appear to retain their leaves. When in leaf, the spreading dark green crown with its yellowish trunk makes a lasting impression.

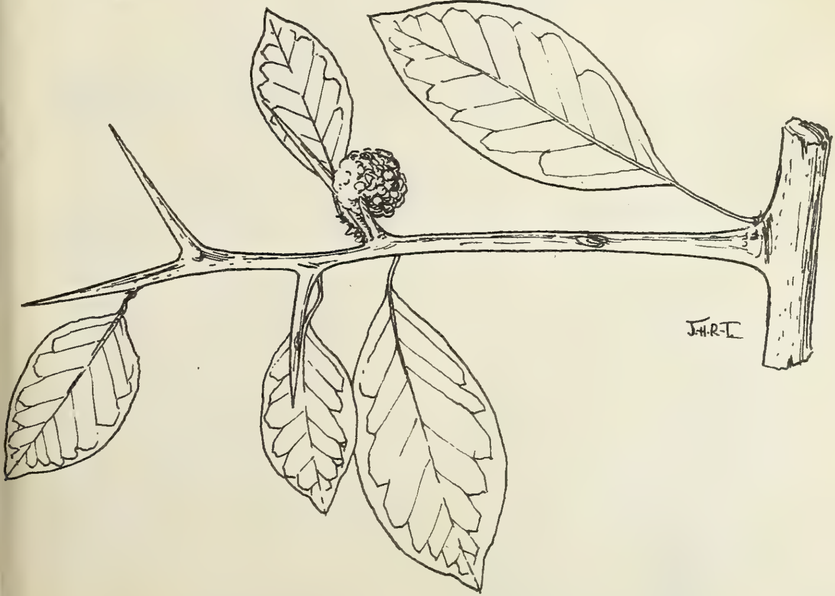
Like the Cape Wild-fig, the fruits are produced on special branched clusters on the main branches (Fig. 17) and are comparatively large. They are sought after by monkeys and many species of birds, while bushbuck, guineafowls and bush pigs pick up the fruits which fall to the ground. Though eaten by the natives to some extent, the figs are usually too full of insects to be attractive.

The Sycomore Fig is one of the most widespread species, extending from the Nile Land through Abyssinia, Uganda and tropical east Africa to the Transvaal lowveld and Zululand in the south.

19. Cardiogyne africana Bureau. Pumbulu (Shangaan). Fig. 18.

This is a much-branched shrub up to 8 or 10 feet high with abbreviated, spine-tipped branchlets, and is also a member of the Fig family. It is recorded from Tanganyika, Nyasaland, Portuguese East Africa and Zululand and has recently been found to occur along the Levubu River, in the extreme north of the Kruger National Park. The small, round fruits are said to be edible, while the wood yields a yellow colouring matter that may be used as a dye.

Fig. 18.—*Cardiogyne africana.*



URTICACEAE. The Nettle family.

Two shrubs belonging to the nettle family occur in the Kruger National Park, namely, *Pouzolzia hypoleuca* and *Urera tenax.*

20. **Pouzolzia hypoleuca** Wedd. NTHADZWA (Shangaan).

A soft, many-stemmed shrub growing up to six feet in height which is found on wooded koppies around Punda Maria and which may be seen in the Rest Camp grounds on the rocky hillside. It is a common species on the bush-covered slopes of the Zoutpansberg, Waterberg and Magaliesberg ranges and extends from Tanganyika and Nyasaland to Natal. The leaves are ovate, 2 to 3 inches long and nearly as broad, broad at the base and tapering to a narrow point, and are carried on long petioles (leaf-stalks). The upper surface of the leaf is dark green, with a white, contrasting, felt-like covering on the under surface, and there is a complete lack of the stinging hairs which are such a noticeable feature of certain other members of this family. The bark is stripped by the natives as a source of fibre.

21. **Urera tenax** N.E.Br. GIANT NETTLE.

A soft shrub with few ascending stems, inhabiting dry, wooded koppies in the southern part of the Park and which is found also in similar situations in the rest of the Transvaal, Natal, eastern Cape Province and Portuguese East Africa. The leaves are broadly heart-shaped, sometimes slightly three-lobed, up to 3 or 4 inches long and of equal breadth. The margins of the leaves are deeply serrated and the leaves and young twigs are well supplied with glandular, stinging hairs, which cause a burning irritation when touched.

The bark provides a strong fibre which is exploited by the natives and, at one time, some consideration was given to the possibility of cultivating the plant for this useful product.

PROTEACEAE. Protea family.

No member of the well-known genus *Protea* has been authentically recorded in the Kruger National Park, though several species are known to occur in the Transvaal. The allied genus *Faurea* (Boekenhout) is, however, represented.

22. **Faurea saligna** Harv. TRANSVAAL OR RED BOEKENHOUT. Fig. 19.

Though common on sandy places in the Waterberg and Zoutpansberg districts, the Red Boekenhout is limited in the Park to the eastern fringe near Pretorius Kop, and the only road in the Park from which trees of this species may be seen is the Numbe circular drive.

It grows to a graceful tree up to 30 feet in height with long, narrow, eucalyptus-like leaves, which develop reddish autumn shades before being shed. The flowers are in dense, drooping spikes, like long tassels, and are produced with the young leaves about September or October. The bark is black and rough and may be used for tanning leather. The wood has a beautiful reticulated grain, resembling the European beech (beukenhout), and varies in colour from pale biscuit to red, but it is short-grained and brittle. The Boekenhout is a protected tree in South Africa.

Faurea speciosa Welw., the Broad-leaved Boekenhout, occurs in the Lowveld between White River and Pretorius Kop, but has not yet been discovered in the Park itself.

OLACACEAE. Sourplum (Suurpruim) family.

Three kinds of Sourplum are distinguished botanically in South Africa, namely, *Ximenia caffra, Ximenia caffra* var *natalensis* and *Ximenia americana* var. *microphylla.* All three have edible fruits which are sought by baboons and by the native races. The fruit consists of a large kernel with a high oil content, surrounded by a soft, sweet-astringent tasting pulp, which is said to make a good jelly. Native women boil the kernels with water to obtain a dark, oily substance which is used to soften their skin skirts. The kernels do not appear to be edible.

The name *Ximenia* (pronounced Zimenia) commemorates Francis Ximenes, a Spanish monk, who wrote about plants of Mexico in the seventeenth century.

Two of the above types of Sourplum have been observed in the Kruger National Park and may easily be distinguished from one another by their fruits and leaves.

23. Ximenia americana L. var **microphylla** Welw. SOURPLUM; SUURPRUIM; NTSENGELE (Shangaan).

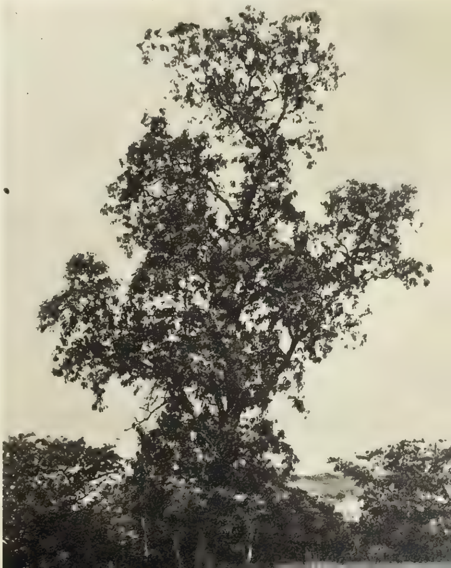
As the name implies, this Sourplum is a variety of the American Hog-plum, *X. americana,* and it occurs from tropical Africa southwards to the northern and eastern Transvaal lowveld and Zululand. In the Kruger National Park, it is mainly associated with the Mopane country north of the Olifants River, but has been found as far south as Tshokwane. It is a much-branched shrub about 6 feet high with spine-tipped branchlets. The leaves are oval, about an inch long, smooth, with a greyish bloom (glaucous). The fruits are oblong, ¾ to 1¼ inches long and yellow in colour.

24. Ximenia caffra Sond. var. **natalensis** Sond. SOURPLUM; SUURPRUIM; UMTHUNDULUKA (Swazi).

Ximenia caffra is a shrub with short, spine-tipped branchlets, the leaves being green (not glaucous as in the previous species) and both the leaves and young twigs are covered with soft short hairs. It grows chiefly on the Magaliesberg, Waterberg and Zoutpansberg ranges, extending into Rhodesia and Bechuanaland. The variety *natalensis* is similar in every respect, except that the leaves become smooth and shiny with age, at least on the upper surface, though the twigs and main leaf-veins on the under surface may still be hairy. Its distribution is more southwards, extending from eastern Transvaal to Natal and it has been observed in the Kruger National Park south of the Sabi River.

In both *X. caffra* and the variety *natalensis,* the leaves are oval, about 1 to 2 inches long and the fruits are oblong, averaging 1½ inches in length, and are bright orange-red in colour. Thus they differ from *X. americana* var. *microphylla* in the larger, non-glaucous leaves and the larger, more reddish fruits.

FIG. 19.—*Faurea saligna,* Transvaal or Red Boekenhout, near Pretorius Kop on the Numbe circular drive.



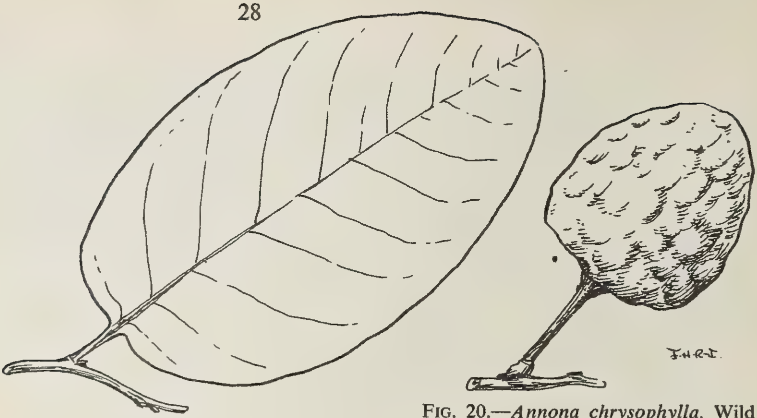


Fig. 20.—*Annona chrysophylla,* Wild Custard-apple, leaf and fruit.

PORTULACACEAE. Spekboom family.

25. Portulacaria afra Jacq. Spekboom.

A shrub with succulent stems and leaves, growing to 10 feet in height, and distributed in dry, wooded places from the eastern Cape Province to northern Transvaal. In the Kruger National Park it occurs naturally on the Lebombo Range, but is never plentiful, while a small planted hedge of it will be seen in the Malelane and Satara Rest Camps.

The leaves are roundish, broader above the middle, up to 1 inch long and are practically stalkless. The small, star-like flowers are rose-pink in colour, but are rarely produced in great quantity. The plants grow easily from cuttings but are sensitive to frost and should be planted in a sheltered position.

ANNONACEAE. Custard-apple family.

Four members of the Custard-apple family are found in the Kruger National Park, namely, *Annona chrysophylla* (Wild Custard-apple), *Artabotrys brachypetalus, Hexalobus glabrescens* and *Monodora junodii* and, of these, the first three have fruits that are edible.

26. Annona chrysophylla Boj. Wild Custard-apple; Muyembe (Shangaan); umTelemba (Swazi). Fig. 20. (=*A. senegalensis* Pers.)

In the Kruger National Park, the Wild Custard-apple is common around Pretorius Kop and occurs somewhat rarely in the Punda Maria area. It is a widely distributed species, extending from the Nile and Upper Guinea, through tropical Africa to the Transvaal and Zululand in the south. It grows as a shrub or small tree up to 8 feet high and is deciduous, remaining entirely leafless for several months.

The smooth, oval to roundish leaves are alternate, about 3 to 4 inches long and $1\frac{1}{2}$ to 3 inches broad, with conspicuous veins on the under surface. The flowers are borne singly in the leaf axils on stalks 1 to $1\frac{1}{2}$ inches long. There are 3 small sepals and 6 petals, the outer three petals being thick and waxy, white in colour and are shed shortly after the flower opens. In the centre of the flower are numerous anthers and numerous free carpels on a dome-shaped platform or torus. The fruit is formed by the growing together of the carpels and torus, forming a fleshy, egg-shaped fruit about $1\frac{1}{2}$ inches in diameter and yellow to orange in colour when ripe. Although edible, the fruit is not nearly as attractive as the better known Custard-apple of America.

27. Artabotrys brachypetalus Benth.

This is a semi-climbing shrub which occurs in northern Transvaal and Portuguese East Africa, and has been collected in the Park on rocky hillsides around Punda Maria. The leaves are elliptical, 1 to 1½ inches long, and the young leaves and twigs are hairy. The fruits are edible and are roughly pear-shaped, about an inch long, carried on stalks about ½ an inch long. The shrub has a peculiar method of climbing by means of hooked flower stalks.

28. Hexalobus glabrescens Hutch. and Dalz. SHAKAMA PLUM; NSHAKAMA (Shangaan). Figs. 21 and 22.

A deciduous shrub or small tree, occurring throughout the tropics and extending as far south as the Transvaal. It is noticeable how, as it reaches its southermost limits, it becomes reduced in stature and, on the Waterberg, may grow only 1 or 2 feet high. It occurs around Punda Maria, where it may grow to a small tree of 8 feet high, and a good specimen may be seen in the middle of the Rest Camp grounds beyond the office.

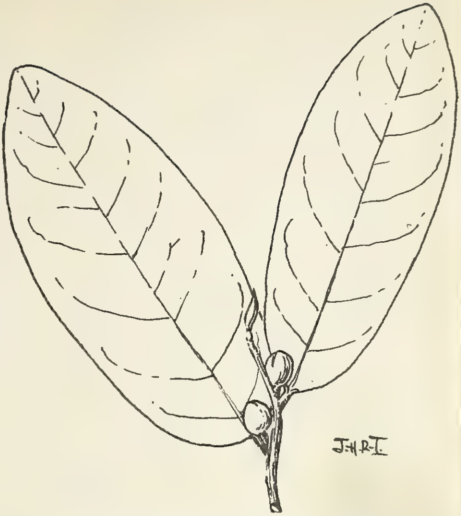
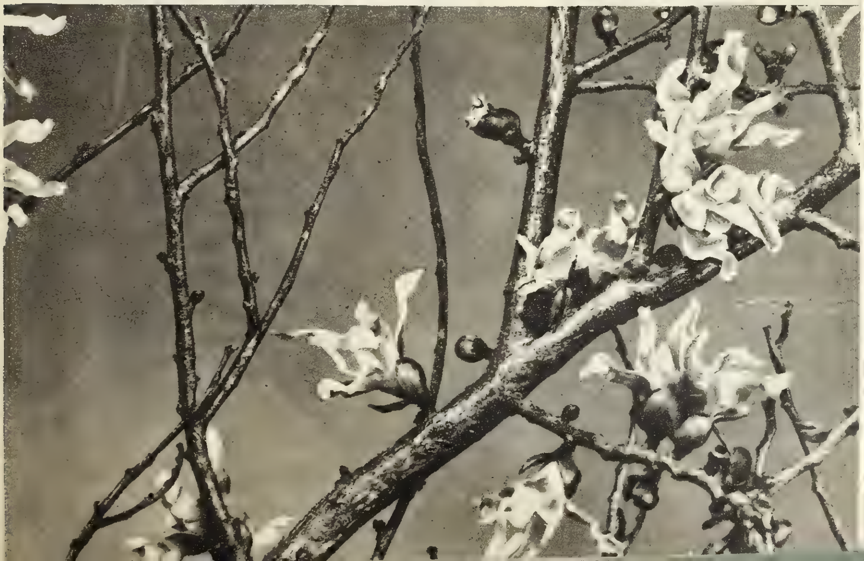


FIG. 21.—*Hexalobus glabrescens*, Shakama Plum, × ¾.

From about March onwards the twigs show numerous small brown buds in the leaf axils, and they open later in October or November into graceful, creamy-white, crinkled flowers, before the leaves appear. The leaves are alternate, elliptical in shape, 2 to 3 inches long and ¾ to 1½ inches broad, with a brownish felt on the leaf-stalks (petioles), main veins on the undersurface, and young twigs. The fruits are edible, irregularly oblong in shape, about 1 to 2 inches long and 1 inch in diameter, fleshy and orange-scarlet in colour when ripe.

FIG. 22.—*Hexalobus glabrescens*, Shakama Plum. A flowering twig.
[*Photo by H. King.*



29. Monodora junodii Engl. and Diels.
MONODORA. TSIVILA (Shangaan).
Figs. 23, 24 and 25.

This is an attractive deciduous shrub about 4 or 5 feet high found only in the northern part of the Park around Punda Maria, and also in the neighbouring territory of Portuguese East Africa. After good rains in early summer it produces masses of brown flowers which hang down like miniature chinese lanterns but unfortunately the flowering period is very short. The fruits are roundish, about 1½ inches in diameter, containing a large number of dry seeds enclosed in a hard shell, and do not appear to be edible.

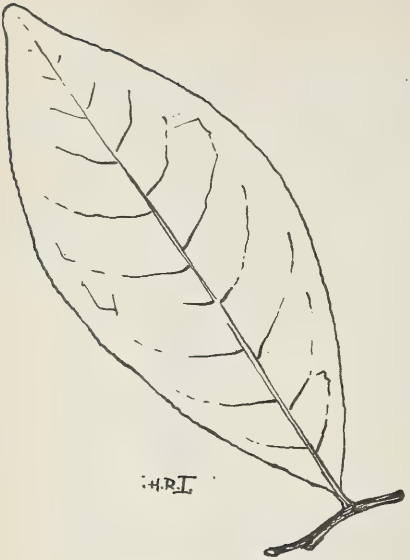


FIG. 23.—*Monodora junodii*, Monodora.

FIG. 24.—*Monodora junodii*, Monodora, in flower near Punda Maria.
[*Photo by Dr. R. A. Dyer.*

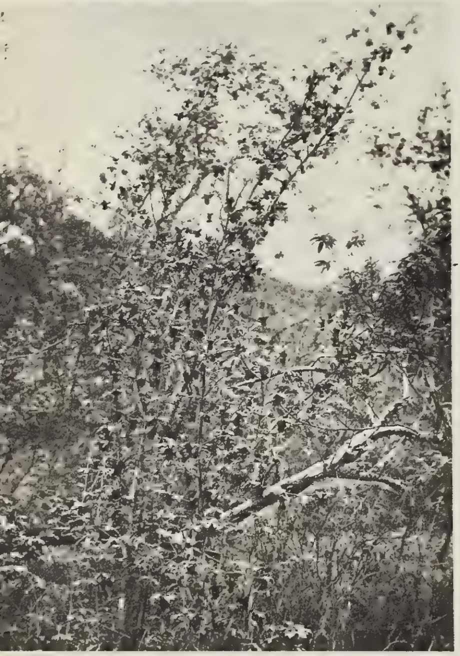
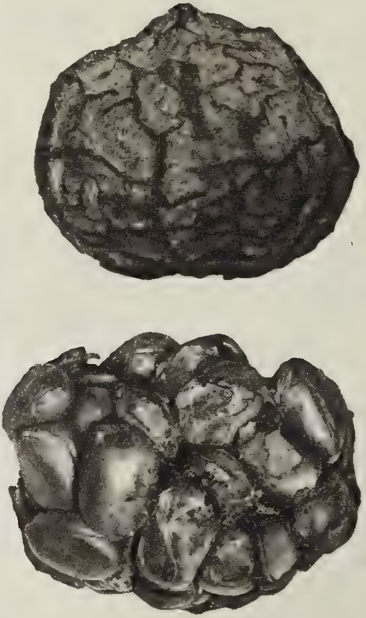


FIG. 25.—*Monodora junodii*, fruits.
[*Photo by H. King.*



HERNANDIACEAE.

30. Gyrocarpus americanus Jacq. Fig. 26.

This interesting species (or varieties of it) occurs in the tropics of America, Africa and Asia and was comparatively recently discovered in South Africa, growing at the north end of Wyllie's Poort in the Zoutpansberg. It has since been found in Portuguese East Africa and near Punda Maria, where it is very rare, usually occurring on densely wooded, rocky hillsides.

It is a deciduous tree up to 40 feet high with a clean, grey trunk, branching well above ground. The leaves are dark green on the upper surface, paler beneath, broad and usually three-lobed as in the diagram with a long leaf-stalk (petiole). The fruit is equally characteristic, consisting of a hard, oval base with two long, flat "wings". The fruits are borne in clusters and, when ripe, they fall off and float gradually to the ground. The wings act as parachutes, causing the fruits to spin in the air and this, no doubt, suggests the generic name *Gyrocarpus*, which is derived from the Greek words meaning "rotating fruit".

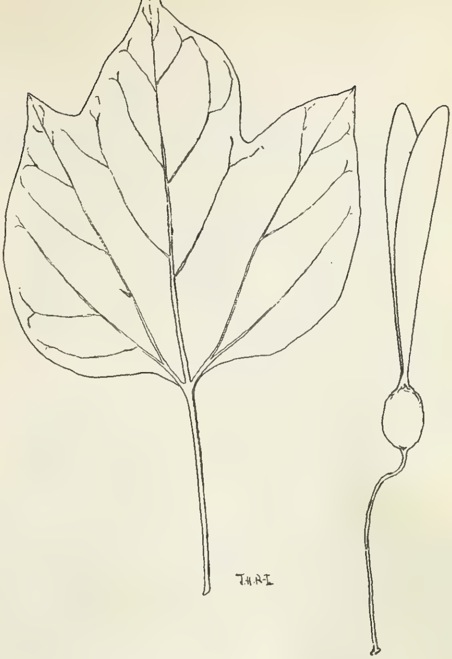


FIG. 26.—*Gyrocarpus americanus*, leaf and fruit, × ½.

CAPPARIDACEAE. Caper family.

In the Kruger National Park there are quite a number of species of shrubs, small trees and woody climbers belonging to the genera *Boscia, Capparis, Maerua, Cadaba, Courbonia* and *Thylachium*—all members of the family Capparidaceae—but nowhere do they assume great importance, and most of them are inconspicuous. Only the first three genera receive further mention.

31. Boscia albitrunca (Burch.) G. & B. WITGATBOOM; MOTLHOPI (Sesuto).

Although this is one of the most widespread bushveld trees, it is rare in the Park, occuring occasionally on rocky koppies north of the Olifants River and near the Gorge. It is well browsed by antelopes and by domestic livestock, but is said to taint the milk of the latter. The wood is white, hard and close-grained, while the roots are roasted as coffee substitute.

32. Boscia hildebrandtii Gilg. MATHEMA (Shangaan). Figs. 27a and 28.

Specimens collected recently in Portuguese East Africa and the Kruger National Park have been found to be very similar to the east African species *B. hildebrandtii* Gilg, but there are small differences which may lead eventually to our plant being separated as a distinct species.

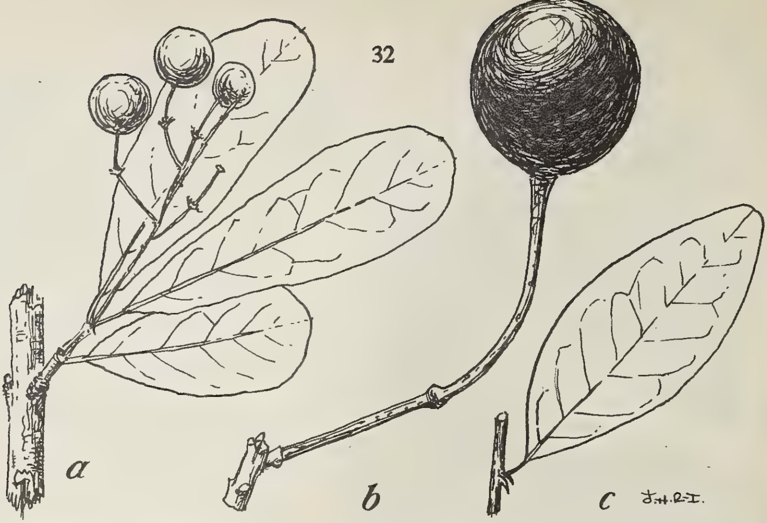


FIG. 27.—a, *Boscia hildebrandtii*, Mathema, fruiting twig, × ¾; b and c, *Capparis tomentosa*, Khawa, fruit and leaf, × ¼.

The plant which occurs in the Kruger National Park is a many-stemmed deciduous shrub with thickish, ascending branches reaching a height of 6 to 8 feet, and is common about 5 to 6 miles south of Skukuza on the road to Malelane, on low-lying, brackish places. The leaves are dark green and smooth, about 1½ to 2½ inches long and ½ to ¾ of an inch wide, broader above the middle and round-tipped, with sometimes a small, sharp extension of the mid-rib protruding. Small, star-like, whitish flowers are produced in sprays in early summer and are followed by the round, dry fruits about ½ an inch in diameter, carried on long, slender stalks.

33. Capparis tomentosa Lam. KHAWA (Shangaan). Fig. 27b and c.

A vigorous woody climber with a wide distribution from Upper Guinea and Abysinnia, through tropical Africa to Natal. It is scattered throughout the Park, but is never common. It has sharp hooked thorns in pairs and the leaves are elliptical, 1 to 2 inches long and ½ to 1 inch wide, grey-green in colour and covered with a soft felt. The flowers are inconspicuous but the fruit is characteristic, consisting of a round, hard sphere about 2 inches in diameter carried at the end of a 6-inch stalk, giving it the appearance of a miniature " knob-kerrie ". Another species, *C. subglabra* (Oliv.) Gilg and Ben. is found in the north of the Park near Punda Maria.

34. Maerua maschonica Gilg. NNONGOLOKO (Shangaan).

A woody, thornless climber with elliptical smooth leaves which are about the same size as those of the preceding species. It is never plentiful, but it so happens that specimens may be seen in the Skukuza and Malelane Rest Camps. The flowers have numerous long stamens which stand

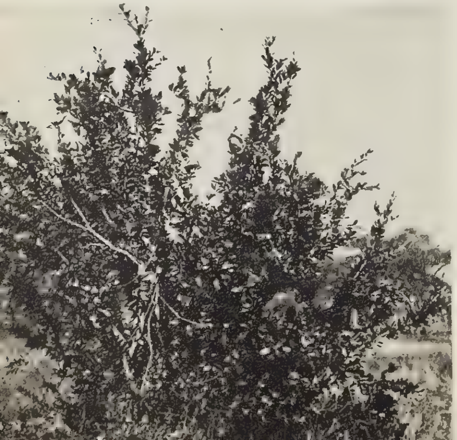


FIG. 28.—*Boscia hildebrandtii*, Matema, near Skukuza.

out like miniature spray-jets, making an attractive show when the plants are in full flower. There are several other species of *Maerua* in the Park, but they are relatively rare and unimportant.

ROSACEAE. The Rose family.

The rose family includes such valuable fruit producing plants as the peach, apricot, plum, apple, medlar, quince, strawberry etc. Only one species of tree size is indigenous to the Park, namely, *Parinari mobola*.

35. Parinari mobola Oliv. MOBOLA PLUM; BOOM-GRYSAPPEL; MBULWA (Shangaan). Fig. 29.

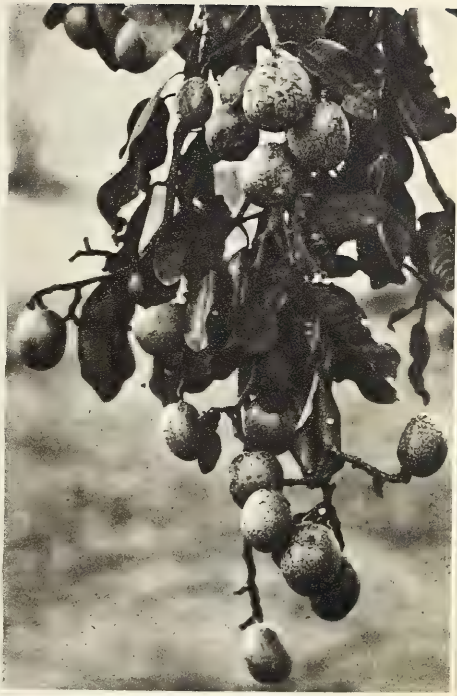


FIG. 29.—*Parinari mobola*, the Mobola Plum, fruiting twig. [*Photo by Dr. R. A. Dyer.*

The Mobola Plum is an almost completely evergreen tree occurring from tropical Africa into Zululand. In the north-eastern Transvaal it grows along the eastern foothills of the Drakensberg, entering the Kruger National Park in the Pretorius Kop and Punda Maria sections. In the neighbourhood of Sibasa, along the northern route to the Park, the Mobola Plum develops into a fine round-topped tree with dark green foliage. On account of its edible fruits, it is one of the few species left standing by the natives in their cultivated lands. Around Pretorius Kop, the tree rarely exceeds 15 feet in height and often grows in rather close groups, so that good specimens are not seen within the Park, though a medium-sized tree is growing in the Pretorius Kop Rest Camp.

The leaves are leathery, oblong-elliptic, about 3 inches long and $\frac{3}{4}$ to 1 inch wide, dark grey-green above and grey below, with prominent side veins at right angles to the central main vein. Flowers are produced in sprays at the ends of drooping branches in early summer. They are small and whitish in colour and are sweetly scented. The fruit is ovoid, plum-shaped, about an inch long, and brown in colour mottled with grey. It consists of a large kernel with a high oil content, surrounded by a fleshy edible covering.

There appears to be very little distinction between our species and another tropical African species, *Parinari curatellaefolium*. It is probable that further investigation will show that our species is a synonym or, at most, a variety, of *P. curatellaefolium*.

LEGUMINOSAE. Acacia, Cassia, pea and bean family.

This large and widespread family of plants, containing over 10,000 species, is particularly well represented in the Park, both as regards number of species and number of individuals. In fact, several species, such as certain thorn trees (Acacias), the Mopane (*Copaifera mopane*) and the Sekelbos (*Dichrostachys glomerata*), tend to form dense and extensive communities, almost to the exclusion of all others. In addition to the trees and shrubs, there are numerous herbaceous species, scattered among the grasses and twining in the light shade of larger bushes. Thus the *Leguminosae* come second to the grasses in the number of species found in the Park.

Leaves: Most leguminous trees have leaves that are compound in structure, that is, the leaves are sub-divided into leaflets. In the Tree Fuchsia (Fig. 63), the Mahogany Bean (Fig. 57) and many others, the leaflets are in pairs along the mid-rib or axis, the whole being, botanically, a pinnate leaf. In certain groups, such as the thorn-trees (Acacias), Albizzia etc., the process of division is carried further: the axis or mid-rib bears pairs of secondary branches and, on these secondary branches, are produced the leaflets. Such leaves are referred to as bipinnate, and the general effect is often "feathery" or "fernlike".

Some bipinnate leaves have leaflets that are extremely minute as, for example, the Haak-en-steek (Fig. 38), where the whole compound leaf does not exceed an inch in length. Constrast this with species like the Wild Seringa and *Albizzia versicolor,* where the ultimate leaflets are large and widely spaced and one complete leaf may be as much as 18 inches long.

Fruits: Throughout the family the fruit is, with very few exceptions, the familiar pod or "' legume", with a row of seeds attached to one side of the pod. The pods of different species may be hard or soft, inflated or flat. In most instances they split open when ripe along one or both edges; in others they may break off cross-wise into short sections, each containing a seed, while rarely they do not split open at all, as in the Nhlaru (page 75). There may also be tremendous differences in size and shape of pods between different species but, essentially, the structure is the same, and it is the fruit character which unites this very variable group into one family.

Flowers: In flower structure, the Leguminosae can be classified into three very distinct groups or sub-families. In fact, they are so distinct and clear-cut that many botanists regard each group as having the status of a family. The three groups are the *Mimoseae, Caesalpinieae* and *Papilionaceae,* and they are described briefly below.

1. Subfamily MIMOSEAE (Acacia and Mimosa subfamily). Here the individual flowers are small and are clustered into dense heads or spikes, the latter having a catkin-like or tassel-like appearance. In each individual flower the sepals and petals (usually 5 of each) are much reduced, while the stamens number 10 or more. Thus the familiar "powder-puff" flower of the thorn-tree is, in fact, a compound inflorescence consisting of numerous small flowers. The fluffy appearance is due to the numerous stamens sticking out in all directions. A glance through a magnifying

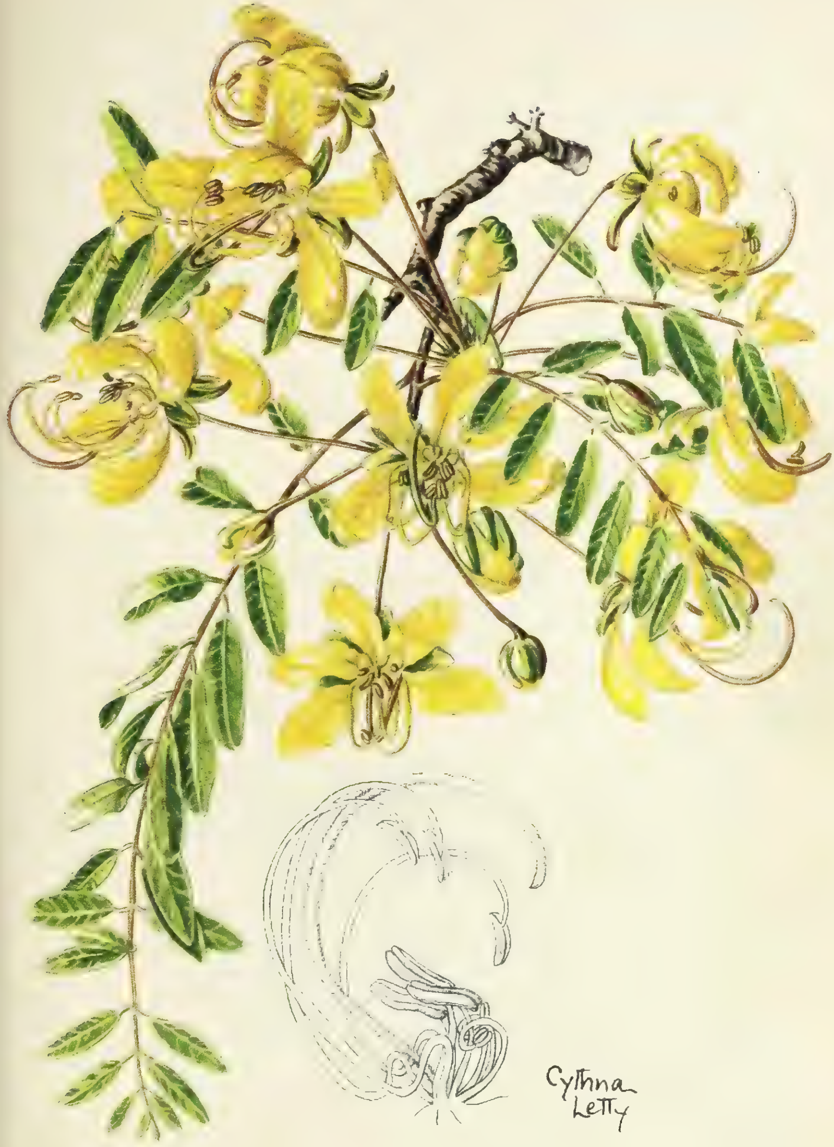


Plate II.

Cassia abbreviata var. *granitica*. Long-tail Cassia or Kersboom (see page 62).

glass at an *Acacia* flower will quickly explain its structure. The genera described later under this heading are: *Acacia* (thorn-trees), *Albizzia* and *Dichrostachys* (Sekelbos).

2. Subfamily CAESALPINIEAE (Bauhinia, Cassia and Boerboon sub-family). In this group the individual flowers are normally fairly large and showy with, usually, 5 inconspicuous sepals and 5 petals, arranged more or less symmetrically. In some species, the petals are reduced to 1 or 0, in which case the sepals may remain small, as in the Mopane, or may become showy as in *Afzelia* (Fig. 57) and *Schotia* (Plate III, page 66). Stamens are normally 10 or sometimes less, usually not joined in a tube as in the pea and bean sub-family. Most members of this sub-family are trees and shrubs and the genera to be described are: *Afzelia* (Mahogany Bean), *Bauhinia, Burkea* (Wild Seringa), *Cassia, Copaifera* (Mopane), *Peltophorum* (Huilbos) and *Schotia* (Boerboon).

3. Sub-family PAPILIONACEAE (Pea and bean sub-family). In this sub-family, the petals of the flowers are arranged in the characteristic manner known to anyone who has examined the flowers of the sweet-pea or garden bean. The sepals are united into a small, green, cup-shaped structure with four or five lobes, hidden at the back of the flower. The petals are normally arranged as follows: the upper and outer petal is usually broad and erect and is called the standard. Two narrower petals, called wings, are arranged one on each side of the standard, while the two lowest petals are joined along the lower margin of each, forming the keel. The stamens are more or less united into a tube inside the keel, and inside the stamial tube is the pistil. The flowers are usually showy and are often sweetly scented. In addition, many contain nectar, and the whole complicated structure of the flower facilitates cross-pollination by honey-seeking insects.

Most species in this sub-family are herbs, but there are also shrubs and trees, including some of the most beautiful flowering trees of the lowveld, such as *Bolusanthus* (Vanwykshout), *Lonchocarpus* (Mbandu), *Pterocarpus* (Kiaat), *Erythrina* (Kaffirboom) and that lovely tree, *Pseudocadia zambesiaca* (the Nhlaru or Nyala bean). Also described are members of the genera *Dalbergia, Mundulea, Ormocarpum* and *Abrus* (the Lucky-bean vine).

Sub-family **Mimoseae.** Acacia and Mimosa sub-family.

Three genera are dealt with under this heading in the following order: *Acacia* (21 species), *Albizzia* (9 species) and *Dichrostachys* (2 species). The species are arranged alphabetically in each genus.

Acacia. The thorn-tree genus.

The generic name is probably derived from the Greek word *acantha* meaning a thorn. One also hears the name Mimosa applied to our thorn-trees, but the true Mimosas are a related group, found mainly in the tropics and sub-tropics of America, while the Acacias, of which there are nearly 700 species, are chiefly natives of Africa and Australia. In South Africa there are about 40 or more species of Acacia, occurring chiefly in the drier bushveld and lowveld regions, and some of them are very well known.

One of the commonest South African species is the Soetdoring or Sweet-thorn (*Acacia karroo*) with its yellow, scented flowers appearing in summer, but this species is extremely rare in the Kruger National Park. Other well-known thorn-trees that are *not* found in the Park are the Kameeldoring (*A. giraffae*), Apiesdoring (*A. galpinii*) and Swarthaak or Hakiesdoring (*A. detinens*).

Economic Uses.—Certain Australian species of *Acacia* (the wattles) are grown extensively for their bark, which is used in tanning leather, but the only commercial product derived from African Acacias is Gum Arabic, collected by the natives from certain species in north Africa.

However, many of our species play a valuable part in the nutrition of grazing animals: the leaves are browsed when green, and dry leaves are picked up from the ground in winter, while the pods of many species form a highly nutritive source of fodder. Acacias, particularly the Knob-thorn and other tall-growing species, are the favourite diet of the giraffe and larger antelopes, such as the kudu.

Evolution of Thorns.—The development of thorns is one of nature's reactions to dry conditions and it is interesting to note how, in different families, different parts of the plant may develop into thorns or spines. Perhaps the commonest method is for the small branchlets to end in a hard, sharp point as in the Sekelbos. In other plants, the leaf-stalks or even the flower stalks may become modified in this way.

In most members of the Leguminosae one will find a pair of small, leafy out-growths (stipules) at the base of the leaf-stalk, where it joins to the main stem. One has only to strip a lucerne leaf carefully from its stem to see the stipules attached one on each side of the end of the leaf-stalk. In the Acacias it is almost invariably these stipules which have become lignified and spiny to produce the familiar thorns of several kinds.

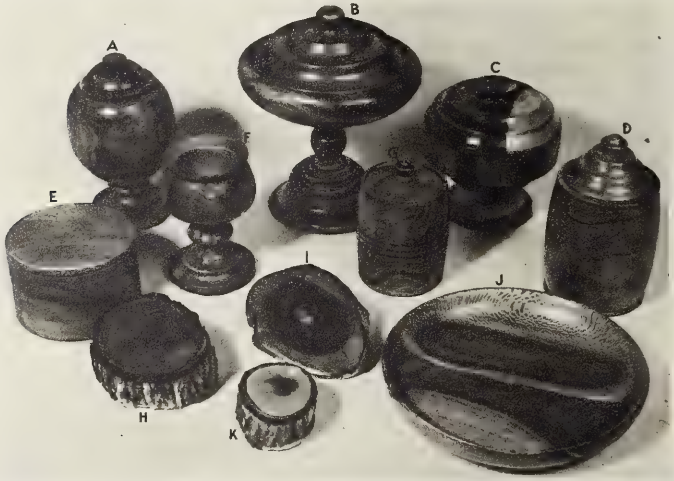


FIG. 30.—Samples of Lowveld woods, prepared by Mr. W. C. E. van Wyk:— A, *Acacia heteracantha,* Umbrella Thorn; B, *Burkea africana,* Wild Seringa; C, *Spirostachys africanus,* Tambootie; D, *Schotia brachypetala,* Tree Fuchsia; E, *Lonchocarpus capassa,* Mbandu; F, *Ziziphus mucronata,* Buffalo-thorn; G, *Pseudolachnostylis maprouneaefolia,* Kudu-berry; H, *Acacia grandicornuta,* Brak Thorn; I, *Dalbergia melanoxylon,* African Blackwood; J, *Faurea saligna,* Transvaal Boekenhout.

[*Photo by H. King.*

Classification of Acacias.—The thorn-trees of the Park are placed in groups below according to their thorn characters, which will assist in identifying the Acacia if a twig is available for study. The reader should then look up the description of each Acacia in the group, taking into account the sketches of leaves and pods and notes on distribution etc. before deciding what species it is. If an Acacia-like tree is found without thorns, it is probably an *Albizzia,* or one of the other leguminous trees or shrubs, such as *Dichrostachys* (Sekelbos), which has spine-tipped branchlets, or *Ormocarpum.*

(i) Thorns in pairs, hooked back like a parrot's beak: *Acacia burkei, A. caffra, A. campylacantha, A. delagoensis, A. dulcis* and *A. nigrescens.*

(ii) Thorns in pairs, straight (or slightly curved in *A. arabica* var. *kraussiana*), sometimes quite small, about ¼ of an inch long but in some species reaching 3 inches in length: *Acacia albida, A. arabica* var. *kraussiana, A. borleae, A. gerrardi, A. grandicornuta, A. karroo, A. robusta, A. swazica, A. woodii,* and *A. xanthophloea.*

(iii) Thorns in pairs, of different kinds, small hooked thorns and slender straight thorns on the same tree: *Acacia heteracantha.*

(iv) Thorns in threes, one hooked backwards and two hooked forwards: *Acacia senegal.*

(v) Thorns not in distinct pairs, but scattered irregularly along the stem, small and hooked: *Acacia ataxacantha* and *A. pennata.*

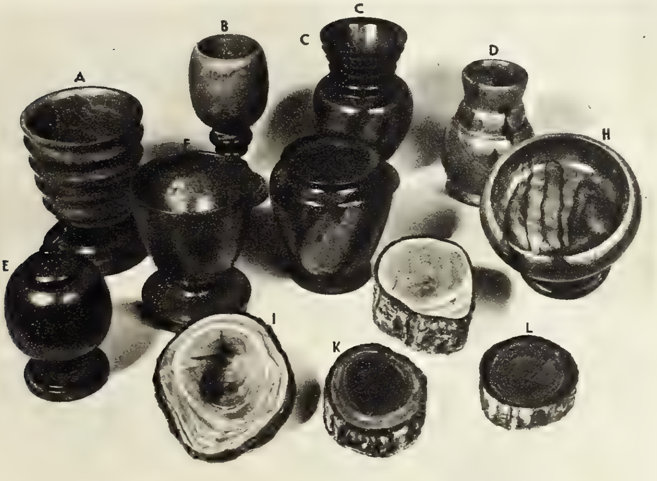


Fig. 31.—Samples of Lowveld woods, prepared by Mr. W. C. E. van Wyk:— A, *Terminalia prunioides,* Lowveld Terminalia; B, *Combretum zeyheri,* Zeyher's Bush-willow; C, *Combretum transvaalense,* Russet Bush-willow; D, *Combretum apiculatum,* Red Bush-willow; E, *Trichilia emetica,* Mkuhlu or Natal Mahogany; F, *Ficus smutsii,* Smuts' Wild-fig; G, *Dombeya rotundifolia,* Wild Pear; H, *Olea africana,* Wild Olive; I, *Sideroxylon inerme,* White Milkwood; J, *Chrysophyllum magalismontanum,* Stamvrugte; K, *Terminalia prunioides,* Lowveld Terminalia; L, *Kigelia pinnata,* Sausage Tree.

[*Photo by H. King.*

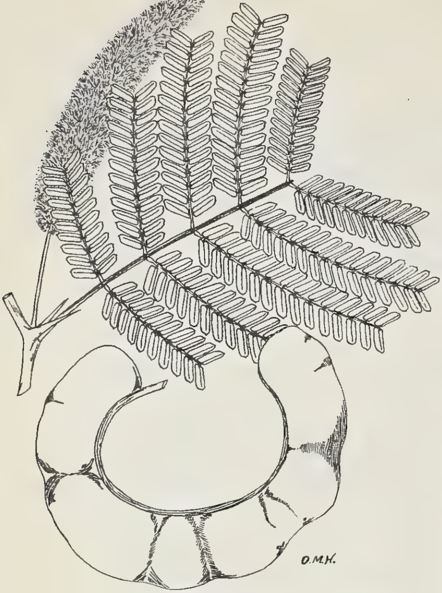


Fig. 32.—*Acacia albida*, Ana Tree, flowering twig and pod, × ½.

36. Acacia albida Del. Ana Tree; Mmolela (Shangaan). Fig. 32.

Ana Tree is the name applied to this species in South West Africa and should be retained in preference to the name Apiesdoring used in the Transvaal for this and two other species of *Acacia*, namely, *A. galpinii* and *A. burkei.*

Acacia albida is a large tree up to 50 feet or more in height with a round crown of grey-green foliage and smooth, white bark. In the Kruger National Park it may be seen along the Levubu River and, in the south, near Crocodile Bridge. It also occurs along the larger rivers of Zululand, Portuguese East Africa, Transvaal, Bechuanaland and South West Africa and is wide-spread in tropical Africa. There is an outstanding group of these trees, recently proclaimed as a national monument, about nine miles north-west of Potgietersrust on the Zaaiplaats road, known as Livingstone's Trees, though the possibility of the famous explorer having seen them is extremely doubtful.

The straight, white thorns are in pairs and the flowers are produced in long, creamy-white spikes 4 to 5 inches long in early spring before the new leaves appear. The leaves are made up of 4 to 5 pairs of pinnae (side branches) with numerous, medium-sized, grey-green leaflets. The pods are broad and curved almost into a ring and are regarded as valuable food for horses and cattle in South West Africa, while it has been noted that elephants and antelopes feed on the pods in the Park. A chemical analysis of the pods showed the following results:—

> Moisture, 8·0 per cent.; ash, 3·3 per cent.; fibre, 27·4 per cent.; ether extract, 0·9 per cent.; protein, 10·4 per cent.; carbohydrate, 50·0 per cent.

Most of the protein is found in the seeds, which account for a quarter of the total weight of pods and seeds, while the greater part of the fibre is contained in the pods.

The wood is light and coarse-grained and is unsuitable for furniture.

37. Acacia arabica Willd. var. **kraussiana** Benth. Redheart; Ruikpeul, Stinkpeul; Nshangwa (Shangaan). (=*A. benthami* Rochbr.) Fig. 33b.

The typical *A. arabica* is native to tropical Africa and Asia, while the variety *kraussiana* is distributed from Tanganyika and Nyasaland southwards to the Transvaal and Natal, where it is a common constituent of the bushveld. It is scattered throughout the Kruger National Park, usually near rivers or in the thorn scrub found on brackish flats.

The Ruikpeul is a small, flat-topped tree or bush up to 15 feet high, with a rough, black trunk. The round, yellow, scented flower-heads

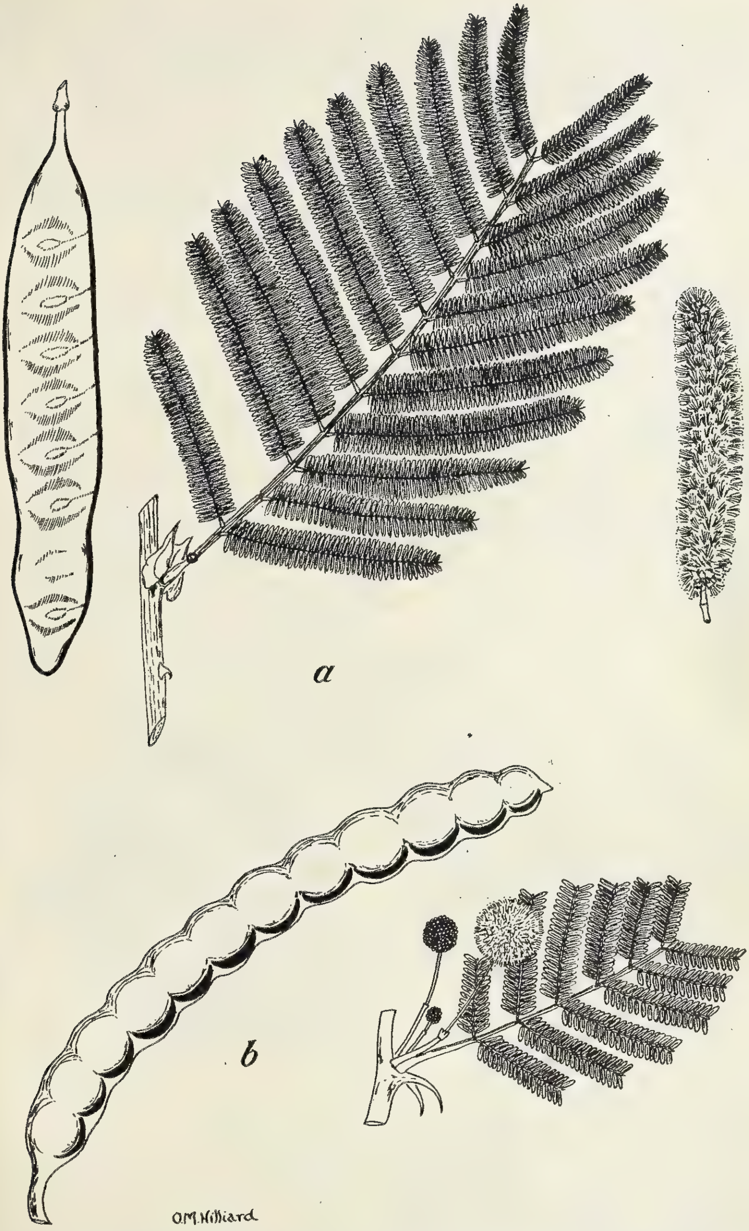


FIG. 33.—a, *Acacia ataxacantha,* Flame Thorn-tree: pod, leaf and flower, × ¾; b, *Acacia arabica* var. *kraussiana,* Redheart: pod and flowering twig, × ¾.

are produced in the late summer and are followed by the characteristic long, pendulous, black pods, constricted between the seeds, giving the pod a beaded appearance. The pods are fairly fleshy, sweet-astringent in taste, and are eaten by antelopes and by domestic livestock. They have quite a high tannin content and are occasionally used for tanning leather.

The leaves are small, 1½ inches to 2 inches long, with very small leaflets. The young twigs, leaves and young thorns may be slightly hairy. The thorns are in pairs, straight or slightly curved backwards when young, greyish in colour, and they vary in length from about ½ an inch to 2 inches.

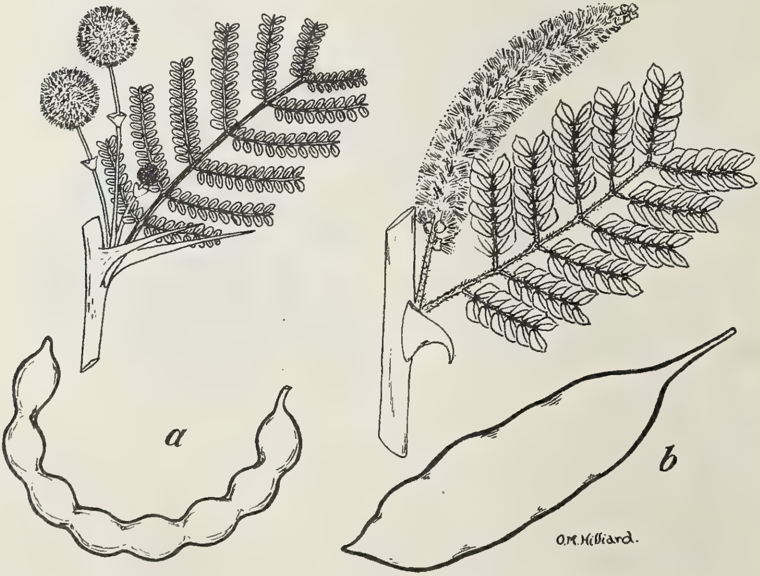
A good quality gum, suitable for confectionery and for adhesive purposes, is exuded from the stems. The wood is reddish, close-grained, hard and durable, and is useful for fencing posts, and also makes a good fuel.

38. Acacia ataxacantha DC. FLAME THORN-TREE. Fig. 33a.

A thorny climber or straggly shrub usually found in wooded kloofs and forest margins, often making dense thickets. In the Park it has been found in patches of thick bush around Pretorius Kop and it is common in parts of the northern Transvaal. Its distribution extends from tropical east Africa to Natal.

Small hook-thorns are scattered irregularly along the stems, not in pairs, and the leaves are composed of numerous very small leaflets. Flowers are produced in creamy-white spikes about 2 to 3 inches long, and the straight, flat pods are borne in clusters at the ends of the branches. The young pods in April or May are bright red in colour,

FIG. 34.—a, *Acacia borleae:* flowering twig and pod; b, *Acacia burkei*, Black Apiesdoring: flowering twig and pod.



appearing like patches of flame in the bush, thus suggesting the common name. The leaves, flowers and pods are somewhat similar to those of *A. caffra* (Kaffir-wag-'n-bietjie), but *A. caffra* has pairs of hook-thorns and, besides, it shows no tendency to develop into a climber.

39. Acacia borleae Burtt Davy. Fig. 34a.

A low, shrubby Acacia, branching freely from the base, with numerous slender stems up to 4 or 5 feet high. It is nowhere common in the Park and occurs mainly south of the Sabi River, extending into Swaziland and Portuguese East Africa. A few clumps may be seen on the road from Pretorius Kop to Skukuza, at the junction of the road which leads off to the Hippo Pool. The round flower-heads are yellow in colour, while the pods are sickle-shaped and distinctly beaded in outline. A characteristic of this species is that the pods and young twigs are covered with glands, making them distinctly sticky to touch.

40. Acacia burkei Benth. BLACK APIESDORING; HAAKDORING, SWART APIESDORING. Fig. 34b.

This species is named after Joseph Burke who collected it near the Magaliesberg in the eighteen forties. It is sometimes known locally as the Apiesdoring, but this name should be confined to that fine bushveld tree, *Acacia galpinii*.

A. burkei is a tree up to 35 feet high, occuring on the northern slopes of the Magaliesberg and is common on sandy flats in the Waterberg District as, for example, around Nylstroom, where some large specimens may be

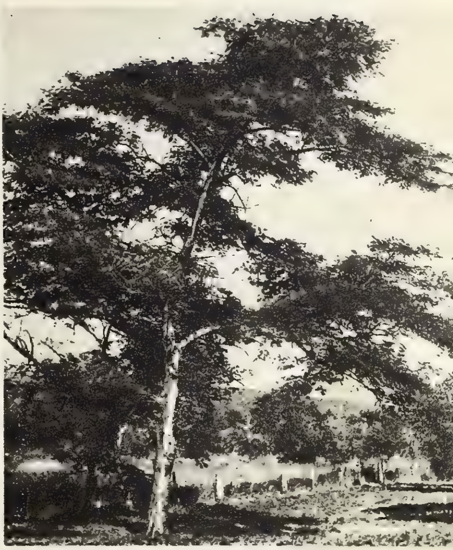
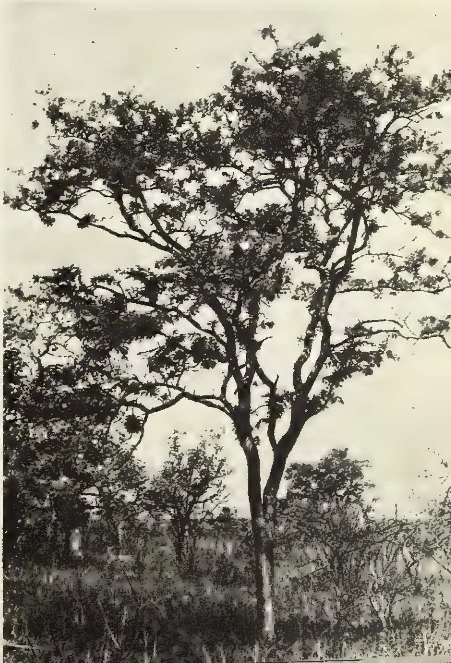


FIG. 35.—*Acacia campylacantha*, White Thorn, in Punda Maria Rest Camp grounds.

FIG. 35.—*Acacia gerrardi*, Red Thorn, near Pretorius Kop.



seen. In the Kruger National Park it is scattered along rivers, chiefly south of the Olifants River, but a few specimens are also found near Punda Maria. The leaves are 2 to 3 inches long with rather few, medium-sized leaflets. The petiole (leaf-stalk) and side branchlets of the leaf are slightly hairy, a character which helps to distinguish this species from the closely related *A. delagoensis.* The flowers are in whitish spikes which are 1½ to 2 inches long. The pods are black in colour, 3 or 4 inches long, usually tapering to the tip, flat and thin in texture.

The wood is light brown in colour and hard, with a beautiful grain when polished. It was used a good deal in the past for wagon building and it lasts well in the ground as fence posts.

41. **Acacia caffra** (Thunb.) Willd. KAFFIRTHORN; KAFFER-WAG-'N-BIETJIE.

This species is widespread in South Africa but is unimportant in the Kruger National Park, a few stunted specimens occuring near Pretorius Kop, for example, on the Jock-of-the-Bushveld road near Ship Mountain.

When well developed, it is a graceful tree, usually with a twisted, rough black trunk, producing its creamy-white spikes of flowers in early summer, followed by clusters of long, narrow, dark brown pods. The hook-thorns are produced in pairs and the feathery leaves are made up of numerous small leaflets.

42. **Acacia campylacantha** Hochst. WHITE THORN; NKOWAKOWA (Shangaan). Figs. 35 and 37.

A deciduous tree, which is widespread in tropical east and west Africa and extends southwards to the north-eastern Transvaal. Around Punda Maria it grows to about 30 feet high and a good specimen may be seen in the Rest Camp grounds. A noticeable feature of this thorn-tree is that the yellowish bark peels off in corky strips and flakes, giving the trunk a whitish appearance, suggesting its common name.

The strong hook-thorns are in pairs and the foliage resembles that of *Acacia caffra,* though the leaflets are more numerous and even smaller than those of *A. caffra.* The flowers occur in whitish spikes and the pods, 3 to 4 inches long by ½ an inch broad, are thin textured and light brown in colour.

43. **Acacia delagoensis** Harms. DELAGOA THORN. Fig. 37c and d.

This thorn-tree is a native of Portuguese East Africa, extending into Swaziland and the eastern Transvaal lowveld. In the Kruger National Park, it grows in groups of tall crooked trees, often associated with *Albizzia evansii* on brackish flats, such as may be seen about 19 miles from Skukuza on the road to Tshokwane and again between Lower Sabie and Crocodile Bridge.

It is very similar to *Acacia burkei* in stature (up to 35 feet high), flower and pod characters. The leaves are also similar, but the leaflets are fewer and smaller and, on the tree, they have a much less dense appearance. A distinguishing character is that the leaf-stalks and side-branchlets of the leaf are free from hairs while in *A. burkei* they are hairy.

44. **Acacia dulcis** Marl. & Engl. BLOUHAAK. Fig. 37a and b.

A widespread species of the northern and eastern Transvaal, usually on sandy or brackish flats, and occuring also in Bechuanaland and South

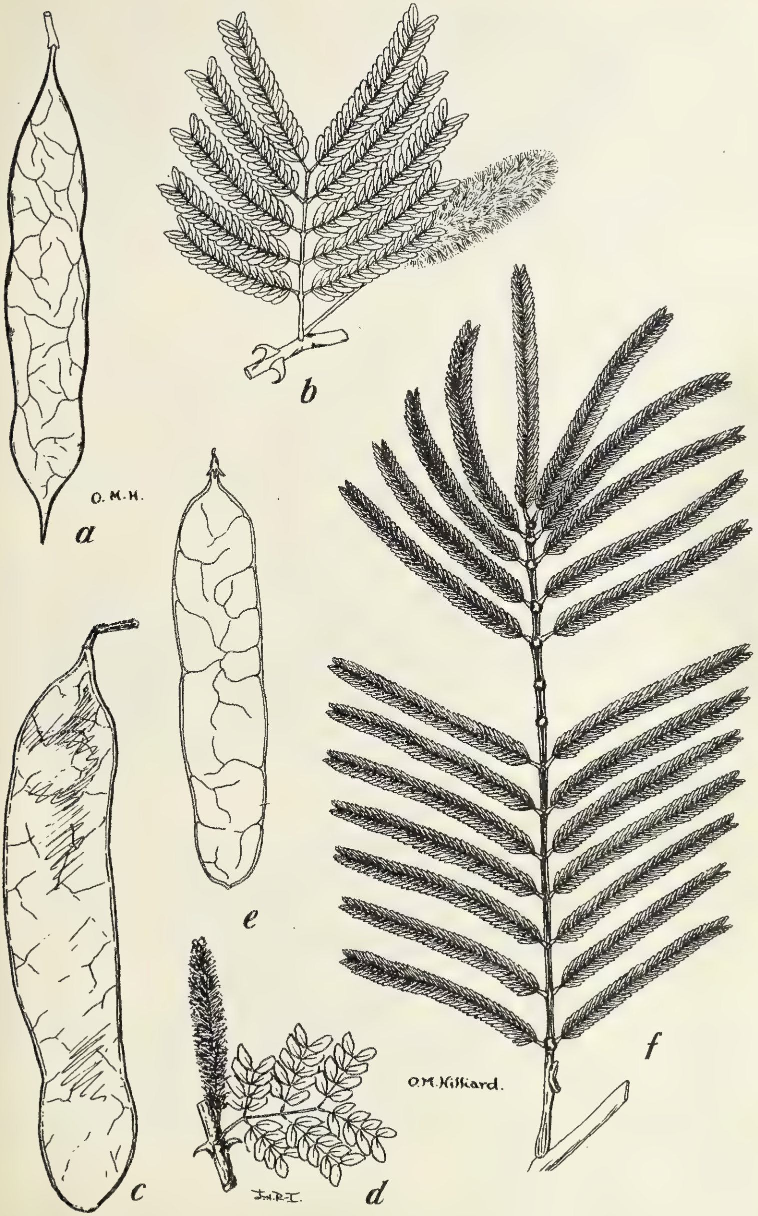


FIG. 37.—a and b, *Acacia dulcis,* Blouhaak: pod and flowering twig; c and d, *Acacia delagoensis,* Delagoa Thorn: pod and flowering twig; e and f, *Acacia campylacantha,* White Thorn, pod and leaf; all × ¾.

West Africa. In the Kruger National Park, it is not an important species and is found south of the Sabi River and, occasionally, near Punda Maria.

It is usually a many-stemmed shrub or small tree up to 15 feet high, with a scaly, greyish-yellow or smoky bark and it is probably the latter colour which suggests the common name " Blouhaak " used by farmers in the north-western Transvaal to designate this species. The flowers are sweet-scented, in creamy spikes about 2 inches long, and the paired hook-thorns are extremely sharp. The pods are 3 to 4 inches long and half an inch wide, straight and thin-textured, and tend to taper towards the end. This thorn-tree is easily confused with smaller specimens of *Acacia burkei,* but the leaflets are smaller and are much more numerous.

45. Acacia gerrardi Benth. RED THORN; ROOIDORING, AAPKOP; SINGA (Swazi). Figs. 36 and 38a, b.

The species name commemorates William T. Gerrard who collected the plant in the middle nineteenth century and of whom Harvey writes in the *Flora Capensis,* 1868, " For several years Mr. Gerrard has devoted himself with an ardour which repeated attacks of fever and repeated thwartings from the unruly conduct and superstition of the natives have not abated, to the exploration of the natural history of Zululand; and the pages of *Flora Capensis* and of *Thesaurus Capensis* so far as published bear ample witness to his success in botanical discovery ".

Acacia gerrardi occurs in northern Zululand, eastern, central and northern Transvaal and in Rhodesia, being particularly common on sandy flats in the Waterberg and Potgietersrust Districts. It is a deciduous tree, 20 to 25 feet high, with few branches reaching upwards to form a narrow, open crown. The leaves are fairly small, about 2 to 3 inches long, with small leaflets. The leaves, young twigs and narrow, sickle-shaped pods are covered with greyish, felt-like hairs. The flower-heads are small, round and whitish in colour. The bark is relatively smooth, grey or reddish and often wrinkled like an elephants trunk. The reddish bark accounts for the common name Red Thorn or Rooidoring, but the derivation of the name Aapkop is not understood. The wood is soft and of no value.

46. Acacia grandicornuta Gerstner. BRAK THORN. Fig 38c, d and e.

This species is a native of southern Africa, occurring in Zululand, eastern and central Transvaal and possibly Bechuanaland. In the Kruger National Park it is often abundant on brackish flats and low-lying places especially in the neighbourhood of Skukuza, and is largely confined to the southern part of the Park.

It is a small, round-topped tree up to 20 feet high, resembling *Acacia karroo* (Sweet Thorn) in shape and in the character of the sickle-shaped pods. Its closer relationship to *Acacia robusta* is, however, evident from the rather large leaflets and the round, white flower-heads, which are produced in spring. The white, straight thorns are in pairs and often develop to three inches in length. The bark on the young branches is a mottled greyish colour, becoming black and deeply striated on the main trunk and older branches.

47. Acacia karroo Hayne. SWEET THORN; SOETDORING. Fig. 38h and i.

The Sweet Thorn is probably the most widespread and best-known species of *Acacia* in South Africa, occuring in all four provinces and is

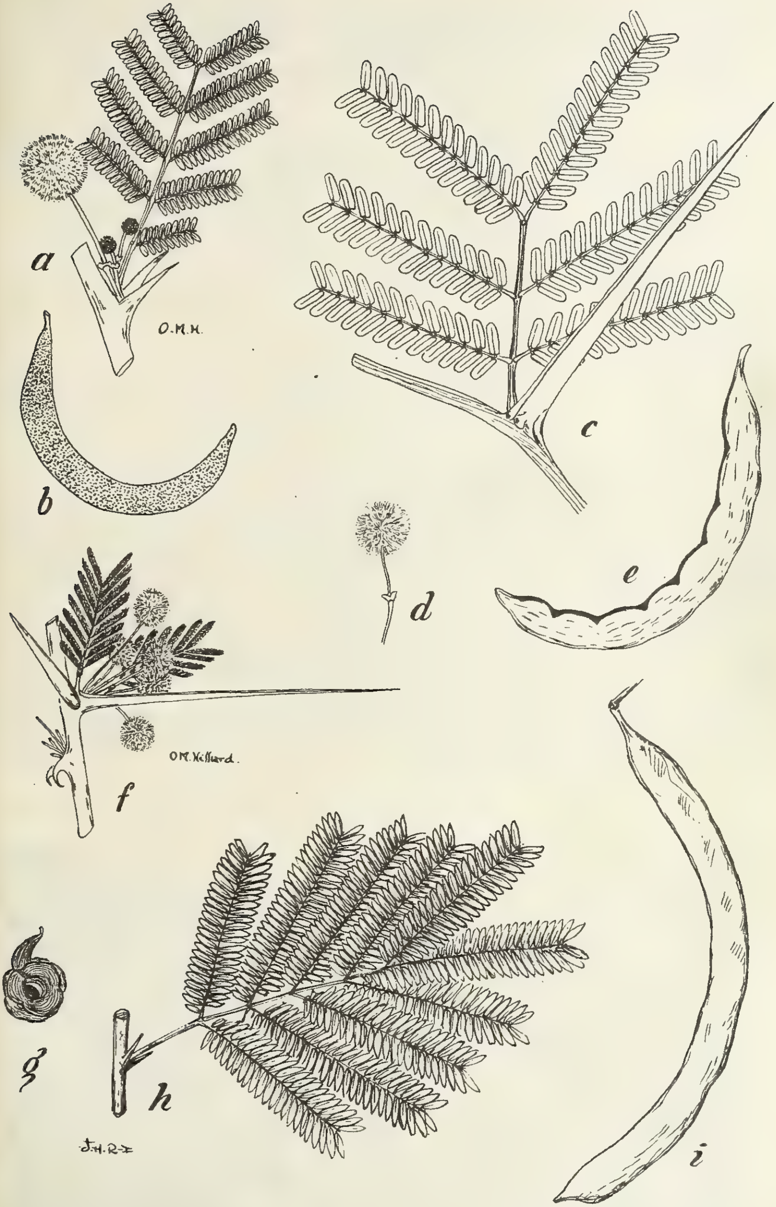


FIG. 38.—a and b, *Acacia gerrardi*, Red Thorn: flowering twig and pod; c, d and e, *Acacia grandicornuta*, Brak Thorn: leaf, flower-head and pod; f and g, *Acacia heteracantha*, Umbrella Thorn or Haak-en-steek: flowering twig and curly pod; h and i, *Acacia karroo*, Sweet Thorn: leaf and pod; all × $\frac{3}{4}$.

recorded also from Rhodesia, Bechuanaland and Nyasaland. It is one of the few trees growing naturally in parts of the Highveld and, in some places, is showing a tendency to spread on grassland that has been depleted by overgrazing. In the Kruger National Park, it is extremely rare, growing as a shrub or small tree up to 12 feet high in wooded kloofs near Pretorius Kop.

The round, yellow flower-heads are sweetly scented and may appear several times during the summer after rainy spells. The pods are narrow and sickle-shaped, though there is much variation in the degree of curving and the extent to which the pod is constricted between the seeds. The straight, white thorns are in pairs and may be up to 2½ inches in length. The bark on the young branches is reddish-brown and becomes rough and black with age. The wood makes a good fuel but is not durable in the ground as fence posts. The bark has been used for tanning, while a good quality gum is exuded from the stems and was at one time exported as "Cape Gum".

48. Acacia heteracantha Burch. UMBRELLA THORN; HAAK-EN-STEEK, WITHAAK; NSASANE (Shangaan). Figs. 38 and 39. (= *A. litakunensis* Burch.)*

This is a widespread and well known species in South Africa and its flat-topped crown is often used in illustrations of our bushveld vegetation. It also occurs in Bechuanaland and Tanganyika. It is scattered throughout the Park, usually on river banks and brackish flats, some of the largest specimens reaching a height of 30 feet along the Levubu River. Umbrella Thorn trees are present in several of the Rest Camps, for example, Shingwedzi, Letaba, Satara and Skukuza.

The thorns are in pairs and are of two kinds—small hook-thorns and long, slender, white thorns. The compound leaf is small, little more than an inch in length and is composed of closely packed, minute leaflets.

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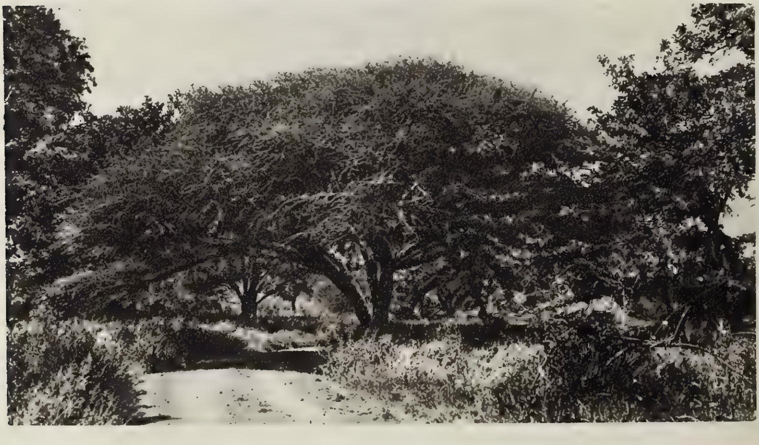
* While previously it was believed that Burchell had two species in mind, recent investigations at Kew have shown that the type specimens of *A. heteracantha* and *A. litakunensis* are identical and therefore the earlier name *A. heteracantha* stands.

FIG. 39.—*Acacia heteracantha*, Umbrella Thorn or Haak-en-steek, near Pafuri.



The young leaves and twigs are softly hairy. The flower-heads are small and round, white in colour and are sweetly scented, being produced in profusion in the summer. They are followed by small, spirally twisted pods, often produced in great quantity, which fall to the ground when ripe in autumn and are readily eaten by antelope and by domestic livestock. The wood is of little value and is fit only for fuel.

49. Acacia nigrescens Oliv. KNOBTHORN; KNOPPIESDORING; NKAYI (Shangaan); UMKAYA (Swazi). (= *A. pallens* Rolfe.) Figs. 40, 41, 42 and 43.

This well known thorn tree is one of the commonest in the Kruger National Park, especially in the drier situations, apparently avoiding moister sites, such as river banks. It is also found in Tanganyika, Nyasaland, Bechuanaland, Rhodesia and Portuguese East Africa, extending to the Transvaal, Swaziland and Zululand.

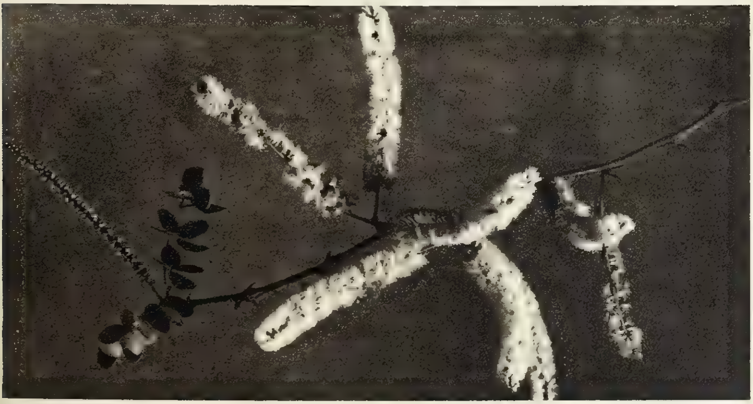
In the north of the Park it occurs mixed with the Mopane while, on the turfy flats between the Olifants River and Satara, it is the dominant large tree, forming, with the Marula, an attractive open parkland with abundant tall grass. In the south, it is strongly associated with black, turfy soil derived from dolerite dykes. The rapid transition from *Combretum* veld on the granite formation to Knobthorn veld on the dolerite dykes is particularly marked on the road from Skukuza to Pretorius Kop.

The Knobthorn is completely deciduous, the trees remaining bare for several months. The flowers appear before the young leaves in August or September covering the trees with masses of creamy-white flower-spikes. The paired thorns are strongly recurved. The pods are thin-textured 3 to 4 inches long and ½ an inch broad and have a blackish colour. The leaves are different from any other *Acacia* in the Park because, on each side-branch of the leaf, only one pair of large leaflets develops.

The bark is rough and black and often dotted with thorn-tipped knobs (see Fig. 41) from which the tree derives its vernacular name. The wood is hard and close-grained with a very dark coloured heart wood and is termite resistant, making good fencing posts and mining props. It is one of the favourite woods for making jukskeis used in the jukskei game.

FIG. 40.—*Acacia nigrescens*, the Knobthorn, is one of the first thorn trees to flower in spring.

[*Photo by H. King.*]



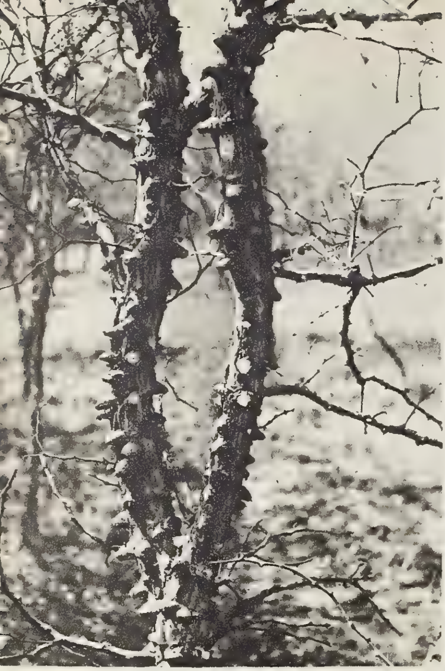
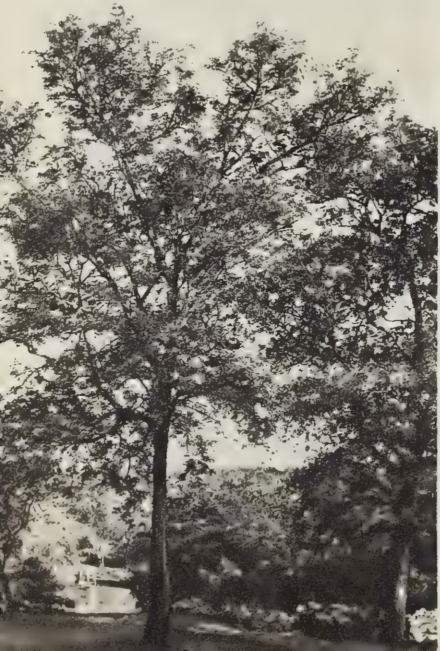


FIG. 41.—*Acacia nigrescens,* Knobthorn or Knoppiesdoring.

FIG. 42.—*Acacia nigrescens,* Knobthorn, at the entrance to Punda Maria Rest Camp.
[*Photo by Dr. R. A. Dyer.*



50. Acacia pennata (L.) Willd.

A straggly shrub or woody climber, resembling *Acacia ataxacantha* in habit. In the Kruger National Park it is found in wooded kloofs and along river banks, often climbing over even the largest trees. It is widespread in tropical Africa, extending northwards to Abyssinia and southwards to Natal.

The small hook-thorns are scattered irregularly along the stem, while the leaves are large, bright green in colour and are composed of numerous small leaflets. Flowers are in creamy-white, round heads, produced in early summer towards the ends of the branches. The pods are straight and flat, about 4 inches long and ½ an inch broad, and light brown in colour.

The leafy twigs do not appear to be grazed by any species of game, with the result that this Acacia can become a troublesome pest.

51. Acacia robusta Burch. Enkeldoring, Engelsedoring, Brosdoring; Munga, Mungamazi (Shangaan). Figs. 43a and b.

This species is apparently confined to southern Africa, being found in the bush country of Natal, eastern Cape Province, Transvaal, northern Cape Province and extending to Portuguese East Africa and Bechuanaland. In the Kruger National Park it is found along most of the larger rivers, and good specimens may be seen at close quarters in the Pafuri and Skukuza Rest Camps.

Acacia robusta was described by Burchell from a specimen he collected near Kuruman and it appears that the trees growing along the coast of eastern Cape Province and Natal and into the Kruger National Park form a distinct variety, with more numerous leaflets and longer pods. Also, the whole tree is larger than the typical

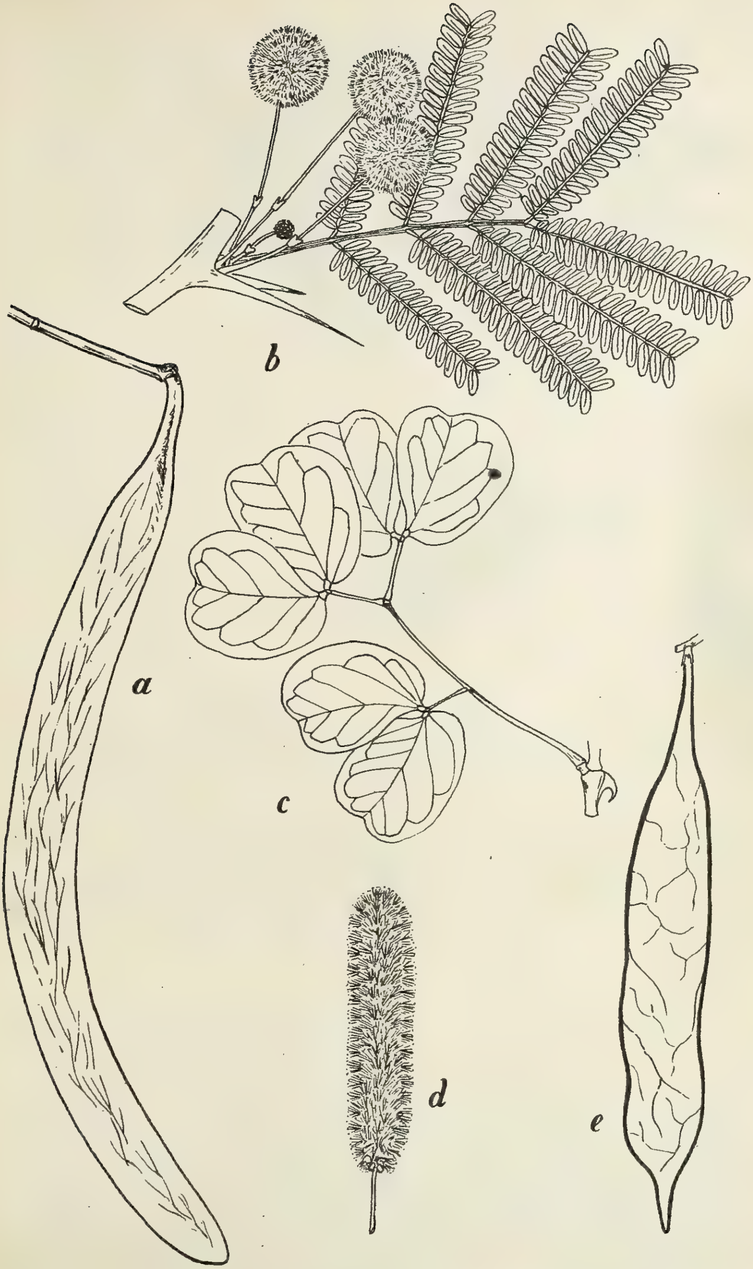


FIG. 43.—a and b, *Acacia robusta,* Robust Thorn or Enkeldoring: pod and flowering twig; c, d and e, *Acacia nigrescens,* Knobthorn: leaf, flower-spike and pod. × ¾.

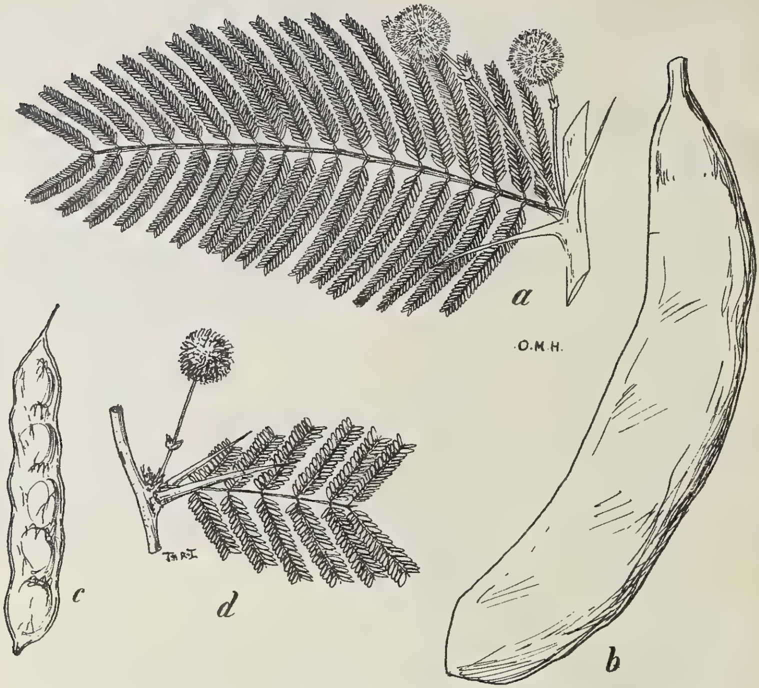


Fig. 44.—a and b, *Acacia woodii,* Paper-bark Thorn: flowering twig and pod; c and d, *Acacia xanthophloea,* Fever Tree: pod and flowering twig, × ¾.

trees of the northern Cape and Transvaal bushveld, reaching a height of 40 to 50 feet along the Sabi and Levubu Rivers.

The paired, large, white thorns arise from distinct swellings in the stems, while the flowers are in white, round balls, appearing with the young leaves in spring. The bark is black and rough and the wood is soft and of no value as timber or fuel.

52. Acacia senegal Willd.

This species is widespread in tropical Africa and extends southwards to the northern and eastern Transvaal lowveld, reaching its southern-most limit on the south bank of the Crocodile River opposite Malelane Rest Camp. It may be seen in the Park on the stony slopes a few miles south of the Olifants River and near the Gorge. The branches are few and erect, up to 20 feet high, making the tree taller than wide, with an open straggly crown. The bark peels in corky, yellowish strips.

The small hook-thorns are in threes, the centre one hooked backwards and the two outer thorns hooked forward. Flowers are creamy-white, in short spikes about 2 inches long, while the pods are straight, about 3 inches long and ½ an inch broad, thin in texture and light brown in colour. The leaves are about 1½ inches long and are composed of usually 4 or 5 pairs of side-branches (pinnae), each bearing 8 to 12 pairs of very small leaflets.

53. Acacia senegal Willd. var. GEELHAAK; SHIN'AYI (Shangaan). (= *A. rostrata* Sim.)

The variety is easily distinguished from the typical *A. senegal* by its different habit of growth, being smaller, up to about 8 feet high, with a flat crown of intricately branched stems, while the foliage is greyish-green in colour. It is common in the southern part of the Park, being particularly prevalent on brackish, sandy flats near Skukuza.

The thorns, flowers, pods and leaves are very similar to those described under the previous heading. The bark on the young stems is greyish and smooth, but on the main stems it tends to peel in greyish-yellow patches. This no doubt suggests the popular name Geelhaak (Yellow Thorn), applied to this bush in parts of the Waterberg District, where it is showing signs of spreading seriously on overgrazed veld.

54. Acacia swazica Burtt Davy. SWAZILAND THORN.

A small, slender shrub 6 to 8 feet high, common in patches near the Pretorius Kop Rest Camp, especially where the grass cover is kept short by grazing animals. With its round, yellow flower-heads appearing in early summer, it is reminiscent of the Sweet Thorn (*Acacia karroo*) and might be mistaken for a stunted specimen of that species at a casual glance. The pods are, however, quite distinct, being broadly half-moon shaped, about 1 inch long by less than ½ an inch broad and covered with sticky glands.

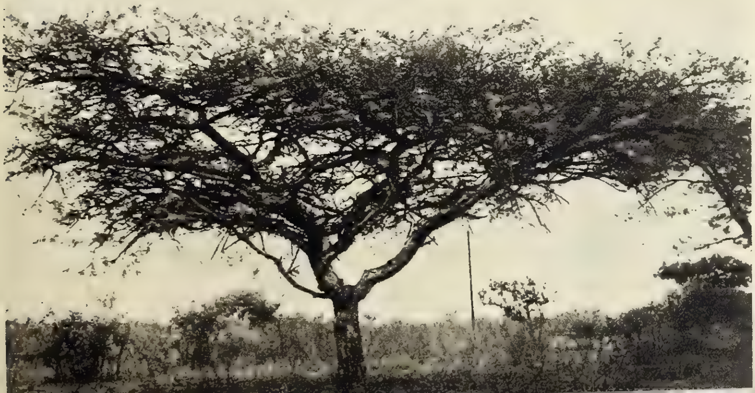
55. Acacia woodii Burtt Davy. PAPER-BARK THORN; PAPIERBASDORING; UMNGANDUZI (Swazi); UMKHAMBE (Zulu). Figs. 44 and 45.

This species is named in honour of the collector and botanist, Dr. Medley Wood (1827-1915) who was, for many years, Director of the Natal Herbarium, Durban.

It has a scattered distribution, extending from tropical Africa to Natal, where it is common in the tall grassland around Estcourt. It is found along the Zoutpansberg Range and in central and eastern Transvaal, extending into the Kruger National Park in the Pretorius Kop and Crocodile Bridge sections. It forms a striking, flat-topped tree, 20 to 25 feet high and of equal spread and is easily recognised by its corky, greyish-yellow bark, which peels off in papery strips and flakes.

The leaves are long, up to 4 inches in length, and are composed of numerous small leaflets. The young leaves and twigs are covered with golden velvety hairs. The flowers are in small, whitish flower-heads

FIG. 45.—*Acacia woodii*, Paper-bark Thorn near Pretorius Kop.



and the pods are thick and heavy, 5 to 6 inches long and 1 to 1¼ inches broad. They are picked up from the ground and eaten by antelope and by domestic livestock. In Natal, cases of livestock poisoning have occurred where animals have fed on young green leaves of this tree knocked to the ground by hailstorms. The wood is light and soft and is of little value.

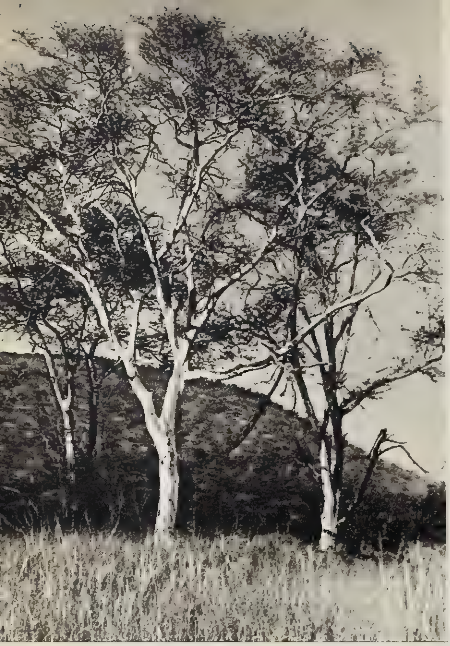


FIG. 46.—*Acacia xanthophloea,* Fever Tree, on the road from Punda Maria to Shingwedzi.

56. Acacia xanthophloea Benth. FEVER-TREE, SULPHUR-BARK THORN; NKELENGA (Shangaan). Figs. 44 and 46.

This tall, deciduous tree is scattered throughout the Park and inhabits low-lying, swampy places in northern Zululand, Portuguese East Africa and eastern and northern Transvaal. It is also found in tropical Africa. Its preference for unhealthy situations has led to the popular name Fever-tree being applied to it and even the early pioneers associated it with fever, though without understanding the reason. In addition, the yellow-green trunk has a sickly appearance, and even the young twigs have the characteristic greenish-yellow, powdery bark.

The paired thorns are straight and white, while the individual leaflets are very small, the whole leaf being only 1½ to 2 inches long. The yellow globular flower-heads are sweetly scented and appear early in summer, while the pods are straight and thin-textured, about 2½ inches long by ⅜ths of an inch wide. Several writers have commented on the small quantity of pods produced by the Fever-tree.

The wood is said to make useful planks, though it should be thoroughly seasoned first or it is inclined to crack. In recent years, the larger Fever-trees have been extensively cut out in northern Zululand for the sake of the timber.

57. Acacia exuvialis Verdoorn.* RISAVANA (Shangaan).

This Acacia, which proved to be an unnamed species, is common in the Kruger National Park and occurs from the Crocodile River to some miles north of the Shingwedzi River. It is largely confined to the Park in its distribution, though some specimens will be found outside the Park between Acornhoek and the Olifants River. Between Skukuza and Malelane it grows as a slender, weak-stemmed tree up to 15 feet high, but it becomes progressively shorter in stature as it extends northwards, probably in response to the drier conditions. Around Letaba and Shingwedzi it forms a shrubby growth up to 5 feet high, and its long, shiny, white thorns make it a conspicuous object in the Mopane veld.

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* Bothalia, Vol. 6, pt. 1 (1951).

The small, yellow flower-heads appearing in early summer bear a resemblance to the Sweet Thorn (*A. karroo*), but the leaves are smaller and the pods are different. The latter are small and half-moon shaped, about 1 to 1½ inches long and are dotted with sticky glands. The pods are also distinctly constricted between the seeds and this, together with the character of the bark, which tends to flake off in thin strips, helps to distinguish it from the closely related species, *A. swazica*.

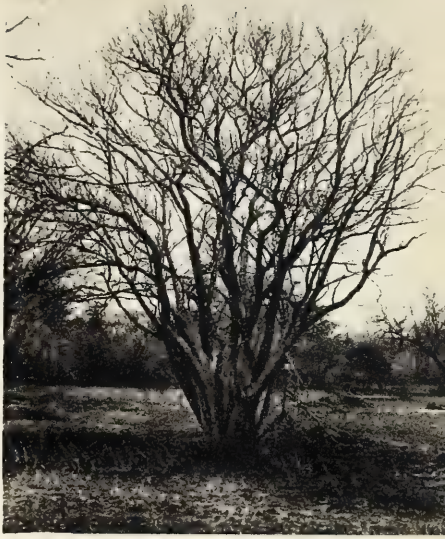


FIG. 47.—*Albizzia evansii*, Nala Albizzia, at Lion Pan, near Tshokwane.

Albizzia.

This genus consists of about 100 species, closely related to *Acacia*, distributed over the warmer parts of Africa, Asia and Australia. It is named after a member of the Italian noble family Albizzi, who introduced plants of this genus into Italy.

Eight species have been observed in the Kruger National Park and they include some very attractive trees, though they tend to remain leafless for a long time. They are invariably without thorns, which helps to distinguish them from the South African species of *Acacia*. The individual flowers are small, but they are grouped together in heads like the Acacias and are often more showy than the Acacias owing to the longer stamens protruding from the flowers. The species described are: *Albizzia anthelmintica, A. evansii, A. forbesii, A. gummifera, A. harveyi, A. rhodesica* and *A. versicolor*. A short note on *A. rogersii* is included under *A. harveyi*, which it resembles very closely.

Although the natives have separate names for most species of *Albizzia*, Afrikaans and English common names appear to be conspicuous by their absence.

58. Albizzia anthelmintica (S.Rich.) Brongn. SHIVULANGUVA (Shangaan).

This tropical African species is found in the north of the Kruger National Park near Punda Maria and is common near Skukuza, where it grows as a shrub or small tree 10 to 15 feet high, mixed with thorn trees along the Sabi River. It is one of the first trees to flower after the winter and in August or September it decks itself in masses of fluffy, white flower-heads, before the young leaves appear. The buff-coloured, flat pods, 4 to 5 inches long and ½ an inch wide follow shortly afterwards.

It is a widespread species growing to a very large tree in the tropics. The bark is said to be used medicinally in the tropics as an anthelmintic, while tests made at the veterinary research laboratory at Onderstepoort show that the pollen acts as a severe irritant to the eyes.

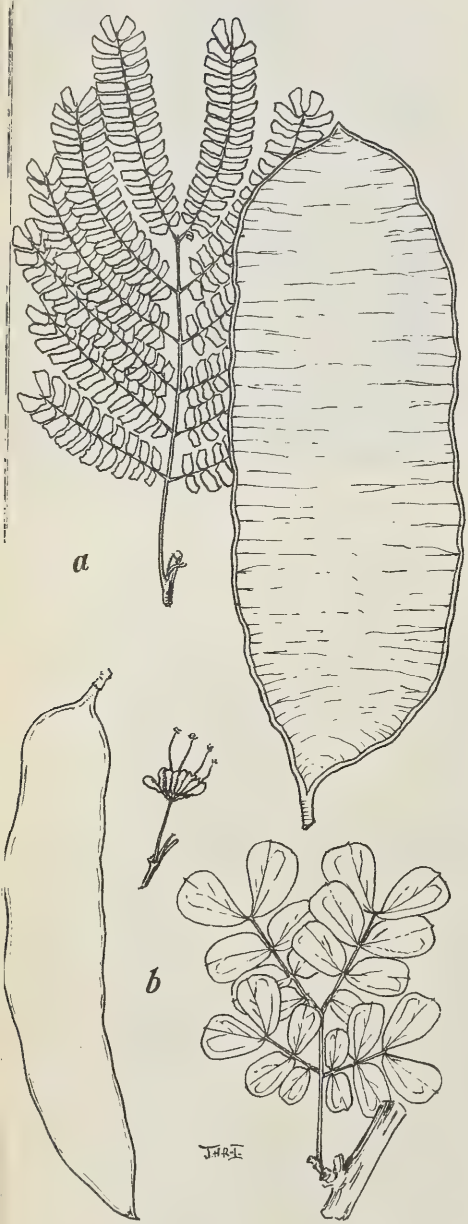


FIG. 48.—a. *Albizzia forbesii:* leaf and pod; b, *Albizzia evansii:* pod, flowers and leaf, × ¼.

59. Albizzia evansii Burtt Davy. NALA ALBIZZIA; NNALA (Shangaan). Figs. 47 and 48b.

The species is named in honour of Dr. I. B. Pole Evans, for many years Chief of the Division of Plant Industry, Pretoria, who discovered it in the southern part of the Park, at that time the Sabie Game Reserve. Its distribution is limited to the Kruger National Park, Portuguese East Africa and northern Zululand, though it is very similar indeed to the tropical east African species, *A. petersiana* Oliv.

It has a very characteristic growth habit, branching freely from the base, with the branches ascending steeply to a height of 20 to 25 feet. This character is shown very clearly in Fig. 47. It remains leafless for several months in winter and the flowers and young leaves appear together about November to December. The flowers of this species and of *A. gummifera* lack the fluffy appearance of other South African species of *Albizzia,* because the stamens are united into a long tube, whereas in other species the stamens are free almost to the base.

Albizzia evansii is of a gregarious nature and tends to grow in groups on brackish, sandy flats, often associated with *Acacia delagoensis.* Communities of this type may be seen 19 miles from Skukuza on the road to Tshokwane, and between Lower Sabie and Crocodile Bridge. One or two isolated trees also occur alongside the road a few miles south of Punda Maria.

60. Albizzia forbesii Benth. Fig. 48a. RINYANI (Shangaan).

This species also has a limited distribution occurring only in eastern and northern Transvaal and Portuguese East Africa. In the Park, it is common along the banks of the Sabie River, eastwards from Skukuza, and is rare in the Punda Maria section.

It is a much branched, spreading tree up to 30 feet high, with drooping branches, and often with several main trunks branching from near ground level. The leaflets are small and closely packed and the whole leaf is only 2 to 3 inches long with 4 to 6 pairs of pinnae (side-branches). The pods are flat, membranous, light brown in colour with darker, transverse ridges, and are about 5 to 6 inches long and 1½ to 2 inches broad. The flowers are like small powder-puffs, whitish in colour, and are produced in November to December, before the appearance of the leaves.

61. **Albizzia gummifera** (Gmel.) C.A. Sm. FLAT-CROWN; PLATKROON.

A stately, deciduous tree with a flat crown, occurring in forest margins from tropical Africa to Zululand. It is very rare in the Park, only a few trees having been observed near Punda Maria.

The leaves are compound as in other Albizzias and are up to 6 inches long with numerous, medium-sized leaflets about ½ an inch long and ⅓ of an inch broad. These leaflets are

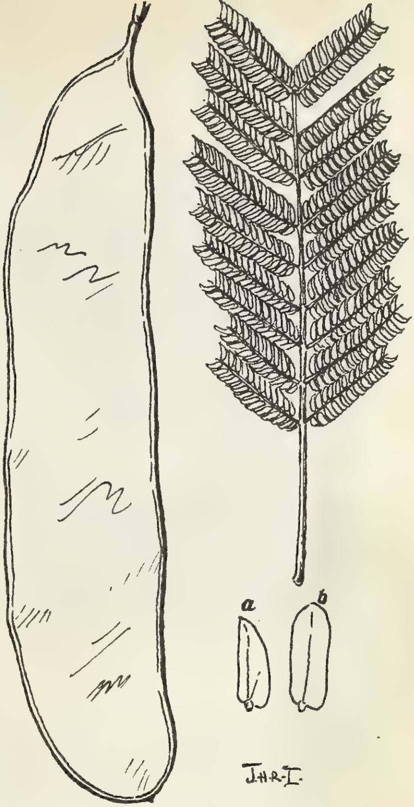
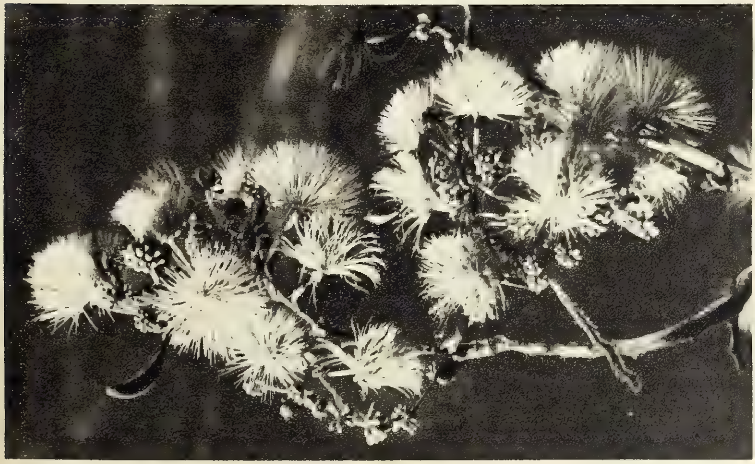


FIG. 49.—*Albizzia harveyi*, Molela. a, leaflet of *A. harveyi* × 4; b, leaflet of *A. rogersii* × 4.

FIG. 50.—*Albizzia harveyi*, Molela. Flowers appear in profusion before the young leaves.

[*Photo by Dr. R. A. Dyer.*



roughly rhomboidal in shape, with the mid-rib running diagonally across the the leaflet. As stated under *Albizzia evansii,* the stamens are united into a tube, so the flower-heads are less showy than in most other species of *Albizzia.*

62. Albizzia harveyi Fourn. NZOLOLWANA, MMOLELA (Shangaan); UMTHOLOLWANE (Swazi). Figs. 49, 50 and 51.

The species name honours W. H. Harvey (1811-1866) who made his first acquaintance with the South African flora when appointed as Colonial Treasurer to the Cape in 1835. Later, as professor of botany at Dublin University, he collaborated with Sonder (see page 24) in the production of the first three volumes of *Flora Capensis.*

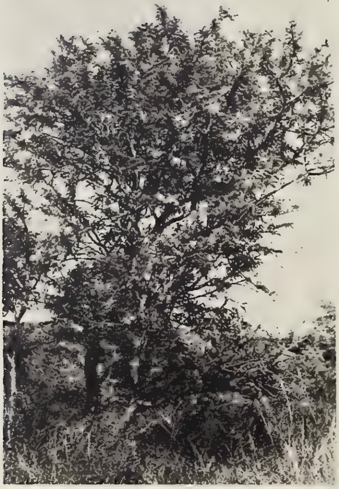


FIG. 51.—*Albizzia harveyi,* Molela, in Punda Maria Rest Camp grounds.

Albizzia harveyi is a common and widespread species in the Kruger National Park and well-grown specimens may be seen in the Punda Maria, Shingwedzi, Letaba and Malelane Rest Camps. Its distribution extends from Bechuanaland and Rhodesia to the Transvaal lowveld and Portuguese East Africa. It is a deciduous shrub or tree up to 25 feet high with finely divided, Acacia-like foliage, producing masses of fluffy, white flowers in October or November before the leaves appear. The flat, buff-coloured pods are 4 to 6 inches long and about ¾ of an inch wide.

It is easily confused with a very similar species, *Albizzia rogersii,* which is somewhat rare in the Park. Both have numerous, small, narrow leaflets but, as will be seen from Fig 49, the leaflets of *A. harveyi* are distinctly curved at the tip. Also, the young twigs of *A. harveyi* are usually covered with golden-yellow hairs.

63. Albizzia rhodesica Burtt Davy. PAPER-BARK TREE; DZUVUDZUVU (Shangaan).

The white trunks with thin, papery bark peeling off in large sheets make this species easy to recognise, and some good specimens may be seen in the Waterberg, north of Warmbaths. It also occurs on the Zoutpansberg range and on the Matoppos, while a few trees are growing on the crests of rocky ridges near Punda Maria.

The trees are often several stemmed and they reach a height of 15 to 20 feet. They remain leafless until early summer when the first large, white, fluffy flowers appear followed by the bronze and green young foliage. The individual leaflets are large, about 1 to 1½ inches long and ½ to ¾ of an inch broad, while the complete compound leaf is up to 15 inches long. The flat, buff-coloured pods are 6 to 8 inches long and 1¼ to 1½ inches wide. The wood is white, soft and very light and a noticeable feature is that when it is being worked, the dust causes a marked irritation to the nose and throat.

64. Albizzia versicolor Welw. MBHESWI (Shangaan); SIVANGATSANE (Swazi). Figs. 52 and 53.

The popular name Umvanghaas is sometimes applied to this tree or to the timber from it, but it should be noted that the natives use the name Mvangatsi exclusively for the Kiaat (*Pterocarpus angolensis*). The confusion is probably due to the similarity of the woods and it is of interest that the Swazi name siVangatsane is the diminutive, meaning the " little Mvangatsi ".

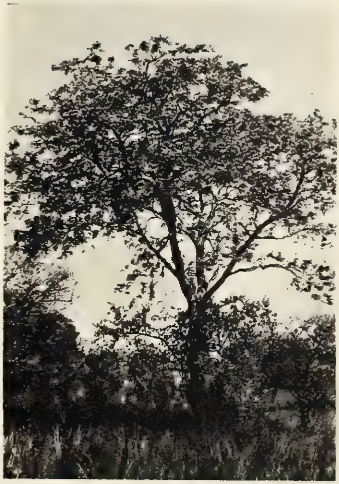


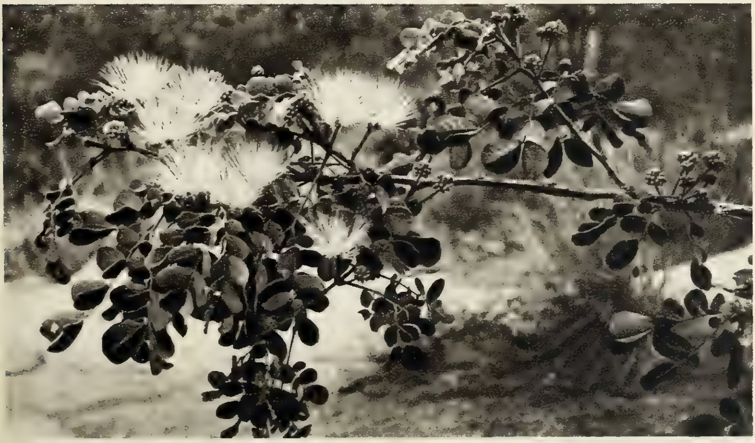
FIG. 52.—*Albizzia versicolor,* near Pretorius Kop.

It is a graceful deciduous tree, 30 to 40 feet in height, usually with a straight, grey trunk, common around Pretorius Kop and somewhat rare near Punda Maria. Trees may be seen in the Pretorius Kop and Punda Maria Rest Camp. Outside the borders of the Park, it is found in Zululand, Portuguese East Africa, eastern Transvaal, Rhodesia, Angola, Nyasaland, Tanganyika and Uganda

Masses of large, fluffy flowers, whitish in colour with a red tinge, are produced in October or November at the same time as the young leaves. Unfortunately, the flowering period lasts only a few days and the flowers rapidly wither. The leaves are compound, up to 15 inches long, with several pairs of side-branches, and the individual leaflets are large and oval to roundish, 1½ to 2 inches long and 1 to 1½ inches broad.

The timber is easily worked, with an attractive brown grain resembling Kiaat.

FIG. 53.—*Albizzia versicolor,* flowering branch.



65. Dichrostachys glomerata (Forsk.) Hutch. & Dalz. SICKLEBUSH, KALAHARI CHRISTMAS TREE; SEKELBOS; NDZENGA (Shangaan). Fig. 54.

66. Dichrostachys nyassana Taub. Popular names as above. Fig. 55.

The main difference between these two species lies in the character of the leaves, *D. nyassana* having larger and smoother leaves and larger leaflets. *D. nyassana* is the common Sicklebush in the open woodland around Pretorius Kop, being found within the Rest Camp grounds, while *D. glomerata* inhabits the thorn-scrub of river banks and brackish flats throughout the Park.

Both species have the attractive, pendulous, fluffy flower-heads, mauve-pink at the upper, thicker end (the female flowers) and yellowish below (the male flowers). The botanical name is appropriate, because *Dichrostachys* is obtained from the Greek words meaning *two-coloured flower-spikes.* The pretty flowers, appearing as they do in midsummer, have also suggested the common name "Christmas tree" for this bush. The clusters of dark brown, twisted pods are identical in both species.

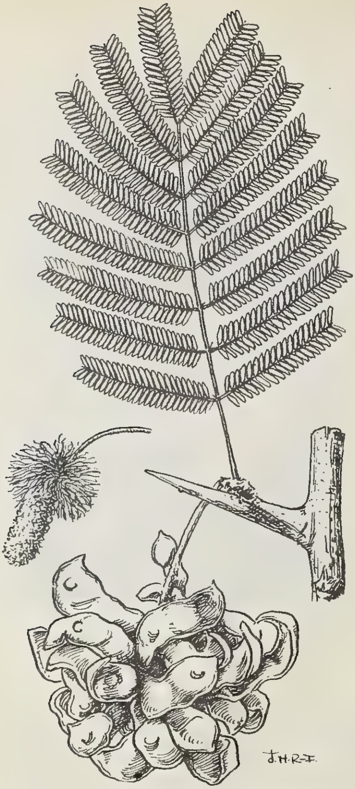
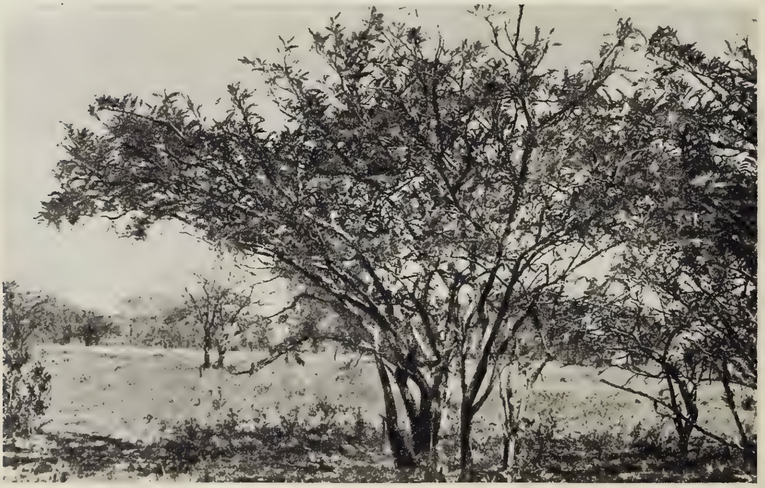


FIG. 54.—*Dichrostachys glomerata,* Sickle-bush or Sekelbos, × $\frac{3}{4}$.

FIG. 55.—*Dichrostachys nyassana,* Sickle-bush or Sekelbos, near Pretorius Kop.



The wood is hard and durable and, being highly termite-resistant, is looked upon as one of the best for use as fencing poles, if straight enough pieces can be found. It is also excellent for charcoal-making and for fuel, retaining its heat for a long time.

In contrast to these useful features, it must be remembered that the Sicklebush can become a serious pest in bushveld where the grass cover has been weakened by overgrazing. Once it is established in thickets, it is a difficult plant to eradicate by mechanical means because, even when the main stems are dug out, many young plants regenerate from the rootlets remaining in the ground. Reports have been received from Cuba that the Sicklebush has become a serious problem there after being introduced to the island some years ago, probably as an ornamental plant.

Sub-family **Caesalpineae.** Bauhinia and Cassia sub-family.

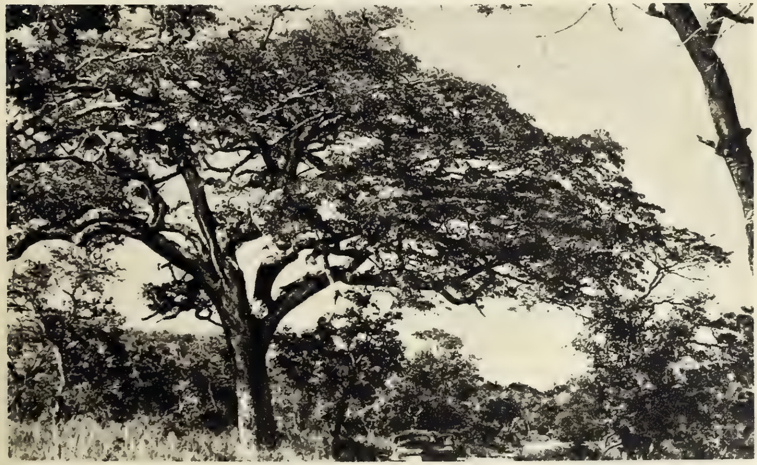
Trees and shrubs belonging to this sub-family of the *Leguminosae* are described in the following order:—

Afzelia quanzensis, Rhodesian Mahogany.
Bauhinia galpinii, Pride of De Kaap.
Burkea africana, Wild Seringa.
Cassia abbreviata, Long-tail Cassia.
Cassia petersiana, Dwarf Cassia.
Copaifera mopane, Mopane.
Copaifera conjugata.
Peltophorum africanum, African Wattle, Huilbos.
Piliostigma thonningii, Rhodesian Bauhinia.
Schotia brachypetala, Tree Fuchsia, Huilboerboon.
Schotia transvaalensis, Dwarf Boerboon.

67. Afzelia quanzensis Welw. RHODESIAN MAHOGANY, MAHOGANY BEAN, POD MAHOGANY, CHEMNEN; NSHENHE (Shangaan). Figs. 56 and 57.

The genus is named after Adam Afzel of Upsala who once resided in Sierra Leone. This species is a medium to large deciduous tree with

FIG. 56.—*Afzelia quanzensis.* Mahogany Bean or Pod Mahogany, a fine tree on the sandveld near Punda Maria.



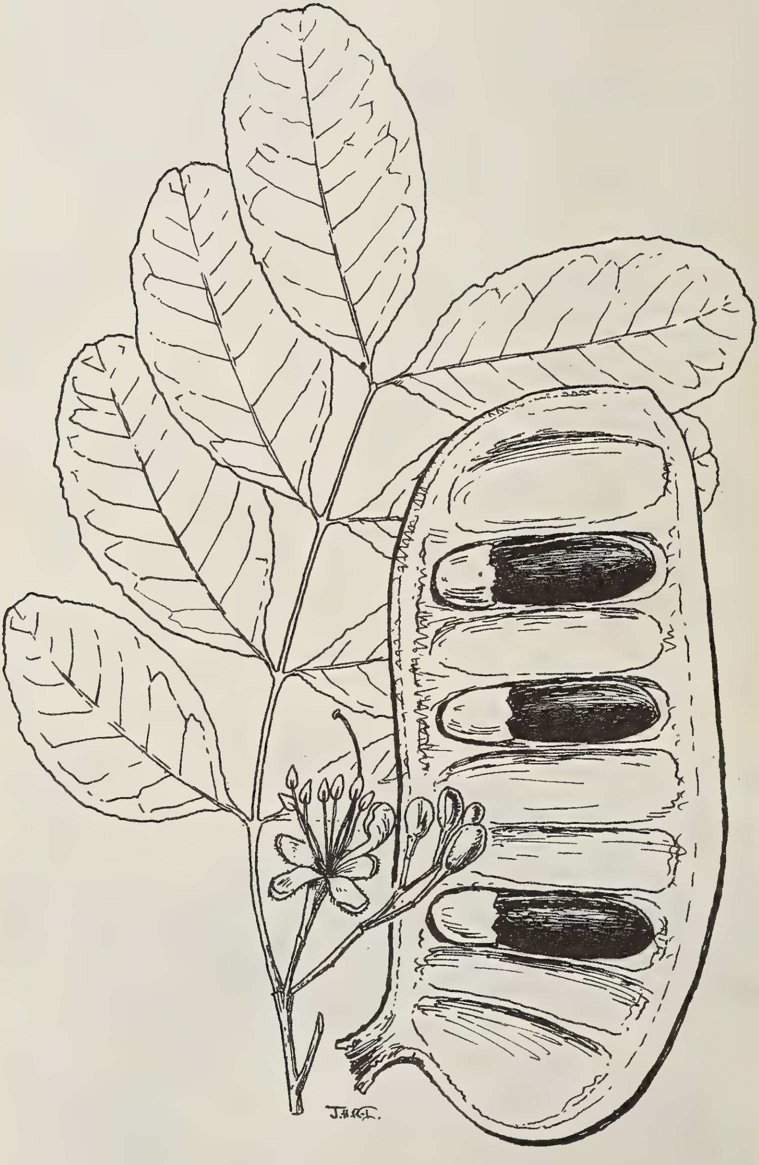


FIG. 57.—*Afzelia quanzensis,* Mahogany Bean or Pod Mahogany. (After Burtt Davy's *Flowering Plants and Ferns of the Transvaal and Swaziland.*)

an extensive, spreading crown and straight, grey trunk. Some particularly fine trees up to 40 feet high and with an even greater spread are found on the "sandveld" in the Punda Maria area and smaller specimens may be seen in the Rest Camp and on small granite koppies between Skukuza and Tshokwane. Its distribution extends from Belgian Congo, Tanganyika, Angola and Nyasaland into Rhodesia, Portuguese East Africa and the north-eastern Transvaal.

The large pinnate leaves are glossy, dark green, with individual leaflets in 4 to 7 pairs, oval in shape and 1½ to 2 inches long by ¾ to 1¼ inches broad. The flowers are in clusters at the ends of the branchlets and are pinkish-green in colour. The five sepals are regularly arranged but only one petal, the lowest, is present, and it grows out like an elongated claw.

The pods are large and woody, 6 to 9 inches long, 2 to 2½ inches broad and about ¾ of an inch thick with up to 8 or 10 large seeds arranged transversely in the pod. The seeds are oblong in shape, over an inch long, black in colour with a red, horny, cup-shaped covering (aril) at one end and they are much in demand as ornaments and charms.

The tree yields a useful, reddish-brown timber, though it is somewhat susceptible to borers.

68. Bauhinia galpinii N.E. Br. PRIDE OF DE KAAP, LOWVELD BAUHINIA; TSWIRIRI (Shangaan); LISOLOLO (Swazi). Fig. 62e.

The genus is named after John and Casper Bauhin, sixteenth century herbalists, the paired leaflets suggesting two brothers.

Bauhinia galpinii is an extremely showy shrub or rambler with red flowers borne in profusion over several months and deriving its popular name from the Kaap River valley, near Barberton, where it is very common. It grows in the Kruger National Park near Pretorius Kop and Punda Maria (in the Rest Camp), usually in bush groups and wooded kloofs, and is also found in Swaziland, Portuguese East Africa and Rhodesia.

The deciduous leaves are two-lobed, resembling a butterfly in shape, which is a characteristic of all Bauhinias. This species is increasing in favour as a garden shrub. It is drought resistant and easily grown from seed, but should be sheltered from severe frosts.

69. Burkea africana Hook. WILD SERINGA; WILDE SERING; MPULU (Shangaan).

The generic name commemorates Joseph Burke, who collected plants in the Magaliesberg area in the eighteen forties, making contact with the early Voortrekkers.

The Wild Seringa is a deciduous tree, common on sandy soils in the Transvaal bushveld and distributed through tropical Africa to Abyssinia and northern Nigeria. In the Kruger National Park it has been observed only on the "sandveld" near Punda Maria, where it grows as a flat-crowned tree up to 35 feet high with a long, straight, greyish trunk.

The compound leaves are up to 12 inches in length, consisting of 2 or 3 pairs of pinnae (side-branches) and numerous oval leaflets about an inch long and ½ to ¾ of an inch broad. Flowers are small and are produced on slender tassels towards the tips of the branches. The seed-pods are flat and hard, oval in shape, and contain 1 or 2 seeds.

The Wild Seringa is regarded as a useful timber tree, producing a hard, fairly coarse-grained wood, varying in colour from reddish mahogany to pale yellow, and is used to some extent for parquet flooring.

70. Cassia abbreviata Oliv. var. **granitica** Bak.f. Long-tail Cassia; Kersboom; Nnumanyama (Shangaan). Plate II (page 34); Figs. 58 and 60.

The name *Cassia* is obtained from an ancient Greek name for a plant of this family. Our tree was previously named *Cassia granitica,* but it is now regarded as only a variety of the tropical *Cassia abbreviata.* It is a deciduous tree, seldom more than 20 feet in height, with a slender trunk and a round crown of graceful, feathery foliage. It is scattered throughout the Park and is also found in tropical Africa, extending northwards to Uganda, while its southernmost limit is the Transvaal lowveld. Trees may be seen in the Skukuza and Punda Maria Rest Camps.

Masses of creamy-yellow, sweet-scented flowers are produced with the young leaves in spring but, unfortunately, the flowering period lasts for only a week or two. Flowers are followed by the peculiar, long, cylindrical pods, up to 2½ feet long and about ¾ of an inch thick. The wood is fairly coarse-grained, light brown in colour, intermingled with darker brown streaks.

Natives say that meat of game is cooked with bark of this tree and eaten as medicine to ensure success in future hunting, hence the origin of the Shangaan name.

71. Cassia petersiana Bolle. Dwarf Cassia; Nnembenembe (Shangaan). (=*C. delagoensis* Harv.).

A deciduous shrub 3 to 5 feet high which is common in the Pretorius Kop area and is found along rivers throughout the Park. The dark green, pinnate leaves are shed for a short time in winter but, for most of the year, make a contrasting background for the yellow flowers, which continue to appear almost throughout the summer and autumn.

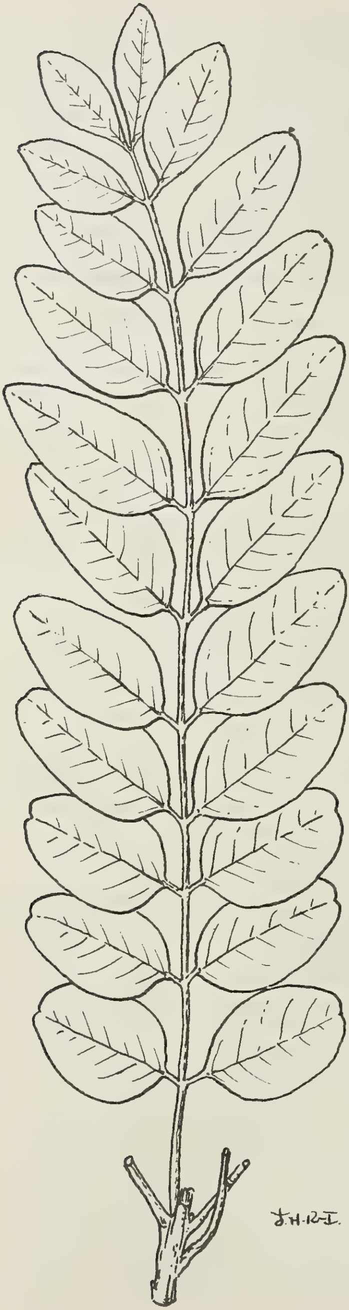


Fig. 58.—*Cassia abbreviata* var. *granitica,* Long-tail Cassia or Kersboom: mature leaf.

72. Copaifera mopane Kirk. MOPANE, MOPANIE; NSHANATSI (Shangaan); MUPANI (Venda). Figs. 59 and 62c, d.

Copaifera is said to be derived from Copaiba, the Brazilian name of the balsam from some of these trees.

Any visitor to the Park who has travelled north of the Olifants River needs no introduction to the Mopane, which is the dominating feature of most of the northern part of the Park. It occurs as dense thickets or as open parkland and reaches its maximum development near Punda Maria in a veritable forest of Mopane trees, 40 to 50 feet high. Here it grows as almost a pure stand, excluding every other species except an occasional Knobthorn, and even grasses cannot survive in competition. It is the commonest tree in the Shingwedzi Rest Camp.

The reasons for the different growth forms shown by the Mopane are not at all clear. The shrub form may be a reaction to cold, or to unsuitable soils, but it suggests that the Mopane is successfully extending its area of domination. So far, however, it is noticeably absent from the deep, white sandy soils between Punda Maria and Klopperfontein, and it avoids the fertile, alluvial river banks.

The leaves of the Mopane consist of two leaflets, resembling the wings of a butterfly, and give off a distinct smell of turpentine when crushed. They turn a yellowish brown colour in winter and are shed irregularly, though by August to September, most of the leaves have dropped. In the summer, leaves react to the mid-day heat by folding along the mid-rib, thus conserving moisture and reducing the amount of shade given by the tree.

Flowers are small and pale green and are produced in slender tassels in October or November with the new

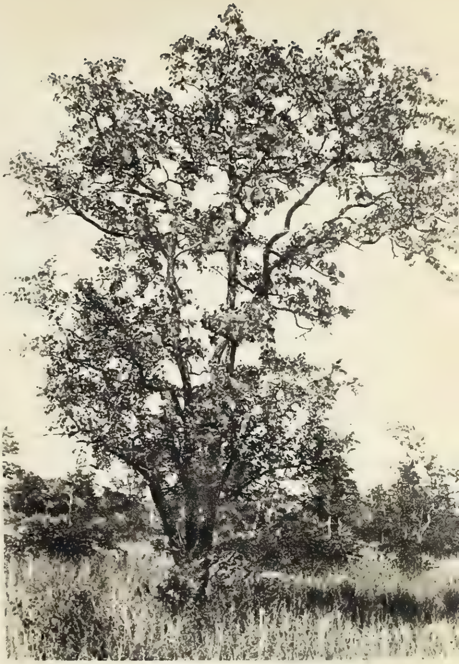
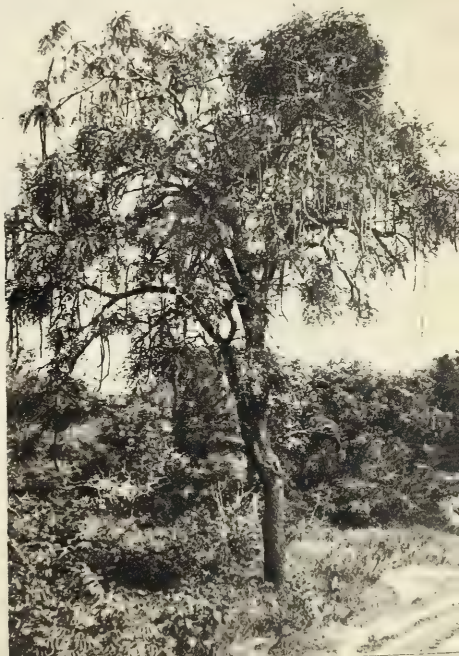


FIG. 59.—*Copaifera mopane*, the Mopane, near Punda Maria.

FIG. 60.—*Cassia abbreviata* var. *granitica*, Long-tail Cassia or Kersboom, near Skukuza



leaves. In adverse seasons, however, the majority of trees do not flower. The flat, half-moon shaped pods, about an inch long and ¾ of an inch broad, are light brown in colour and contain a single, flattened seed which is wrinkled and dotted with oil glands.

The bark is greyish-brown and deeply striated while the wood is resinous and burns well, though with a good deal of smoke, leaving a white ash containing over 50 per cent. of lime. As a timber, Mopane wood is hard, heavy and durable, but too difficult to work for furniture, though the red heart-wood contrasting with the yellow sap-wood is very attractive.

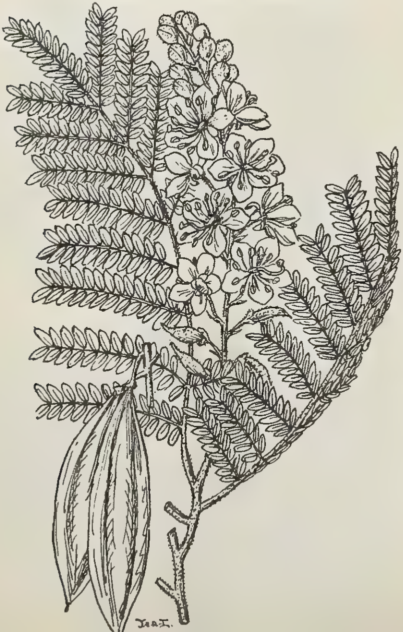
Opinions differ as to the value of the Mopane as fodder. When cattle become accustomed to it they browse it readily and it has a high feeding value, while the aromatic resin apparently does not impart a taint to the milk or flesh. Elephants are frequently seen stripping off the green shoots of the Mopane, but the various antelopes seem to prefer picking up the dead leaves from the ground in winter.

73. Copaifera conjugata (Bolle) Milne-Redhead. NTSOTSO (Shangaan). Fig. 62a and b.

The recent discovery of some trees of *Copaifera conjugata* near Punda Maria provided the first record of this species in South Africa, though it had previously been collected from the adjoining territories of Southern Rhodesia and Mocambique. It grows up to 30 feet high on sandy soil at the foot of quartzite ridges. The trunks are more slender than the closely related Mopane and the bark is relatively smooth with a mottled greyish colour.

The leaves have the same two-lobed character as the Mopane, but the lobes are more rounded at the tips. The pods differ from those of the Mopane in being more oval in shape and tapering to the stalk. They are about 1½ inches long and 1 inch broad and, like the Mopane, are one-seeded.

FIG. 61.—*Peltophorum africanum*, African Wattle or Huilbos. × ¼.



74. Peltophorum africanum Sond. AFRICAN WATTLE; HUILBOS; NDZEDZE, NHLANHLANHU (Shangaan). Fig. 61.

A deciduous, round-topped tree, 15 to 20 feet high, with finely divided, Acacia-like foliage, though it is easily distinguished from an Accacia by the absence of thorns and by the large, showy flowers.

Although scattered throughout the Park, it is most noticeable around Pretorius Kop because the attractive sprays of yellow flowers appear in November or December, when the remainder of the Park is closed. It is also common in theTransvaal bush-veld and is scattered throughout the dry, bush country of Angola, Rhodesia, Bechuanaland and Portuguese East Africa. Trees may be seen in the Skukuza, Pretorius Kop and Crocodile Bridge Rest Camps.

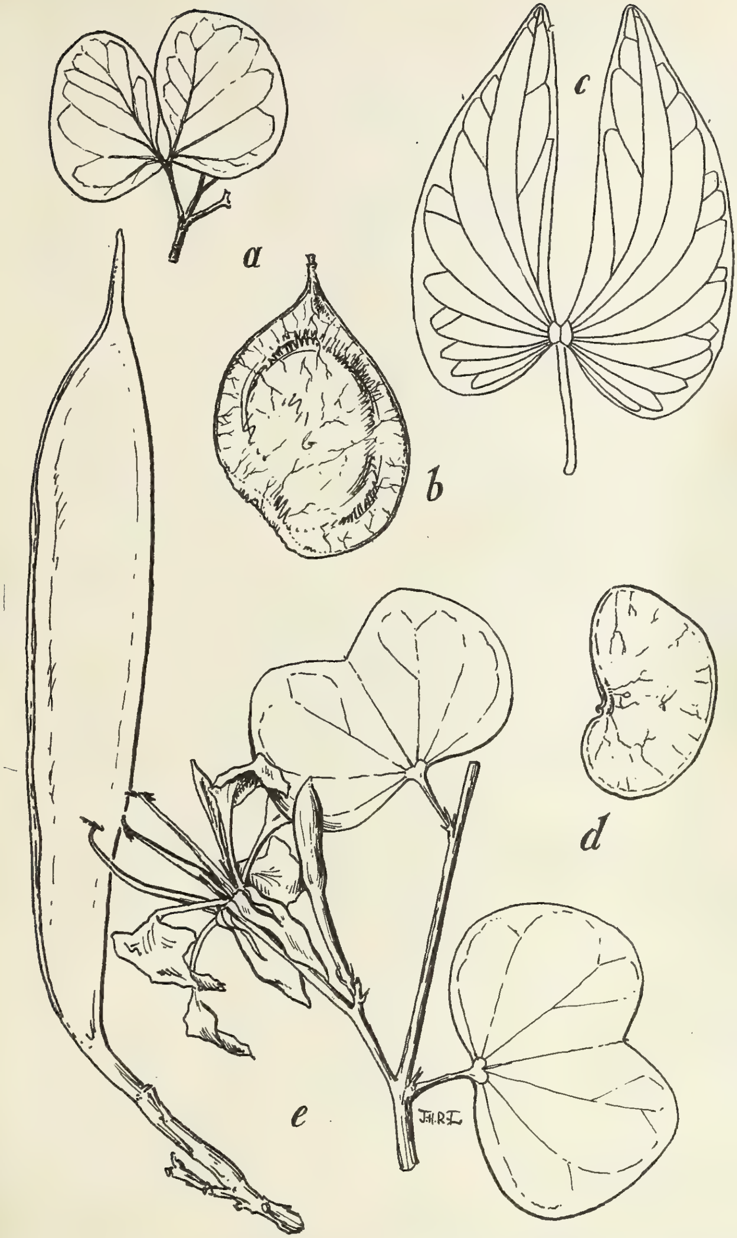


Fig. 62.—a and b, *Copaifera conjugata:* leaf and pod; c and d, *Copaifera mopane,* the Mopane, e *Bauhinia galpinii.*

The young leaves and twigs are covered with a golden-brown felt. The flat pods are one or two seeded, about 1½ inches long and tapering to each end, and are frequently retained on the tree after the leaves fall.

The wood varies from light to dark brown and is useful where a non-splitting wood of medium hardness is required. The natives make axe-handles, sledges and stamp-blocks from it. The bark is used medicinally, an infusion being taken for stomach troubles.

75. Piliostigma thonningii (Schum.) Milne-Redhead. RHODESIAN BAUHINIA; KOLOKOTSO (Shangaan). (=*Bauhinia thonningii* Schum.)

A shrub or small tree up to 15 feet high, growing in and around Pretorius Kop Rest Camp and Punda Maria, a tree occurring beside the Punda Maria Rest Camp grounds. It is widespread in tropical Africa, extending from Abyssinia and Nigeria to the Transvaal lowveld.

The leaves are two-lobed like Bauhinia leaves, but the flowers are much smaller. They are white in colour with crinkled petals, falling soon after they open and, as the flowering period is over in a week or two, this species has little ornamental value. The leaves are shed early, leaving the tree bare for several months in winter. The pods are large and heavy, about 6 inches long and 1½ inches broad, sometimes with a half twist when young and soft, but becoming woody and light brown in colour as they mature.

76. Schotia brachypetala Sond. TREE FUCHSIA; HUILBOERBOON; uVOVOVO (Swazi and Shangaan). Plate III; Fig. 63a.

Schotia commemorates Richard Schot, companion of the botanist Jacquin during his travels in America from 1754-59.

The Tree Fuchsia or Huilboerboon is a beautiful tree with dark green, pinnate leaves and branched clusters of dark red flowers borne on the old wood in early spring. It is one of the larger trees found along river banks in the southern part of the Park and specimens may be seen in the Pretorius Kop, Skukuza and Malelane Rest Camps. It reaches 35 to 40 feet in height and its distribution ranges from the central Transvaal bushveld to northern Zululand.

It may be described as evergreen, though sometimes the leaves are shed for a short time before flowering starts. It is noticeable that the Huilboerboon does not flower freely every year, but in good seasons it is an unforgettable sight. The flowers are so well supplied with nectar that the tree "weeps" when it is in flower, while a small shower is caused by shaking a flowering branch, and this no doubt accounts for its common name, the "Weeping Boerboon"

In this species the petals are much reduced, but the red sepals and stamens compensate for the lack of petals. An allied tree in which the petals do develop has been described as a separate species, *Schotia rogersii* Burtt Davy, and it is found in the northern Transvaal and near Punda Maria. In all other respects it is identical with *Schotia brachypetala.*

Both species have pinnate leaves with, normally, 4 pairs of oval leaflets 1 to 1½ inches long and ½ to 1 inch broad. The broad, rather heavy brown pods are about 4 inches long by 1½ inches broad and contain 6 to 8 seeds, light brown in colour with a conspicuous, horny, yellow covering (aril) at one end. More often than not, the seeds are parasitised by insects, but healthy seeds germinate readily. The trees are slow growing and are sensitive to frost.

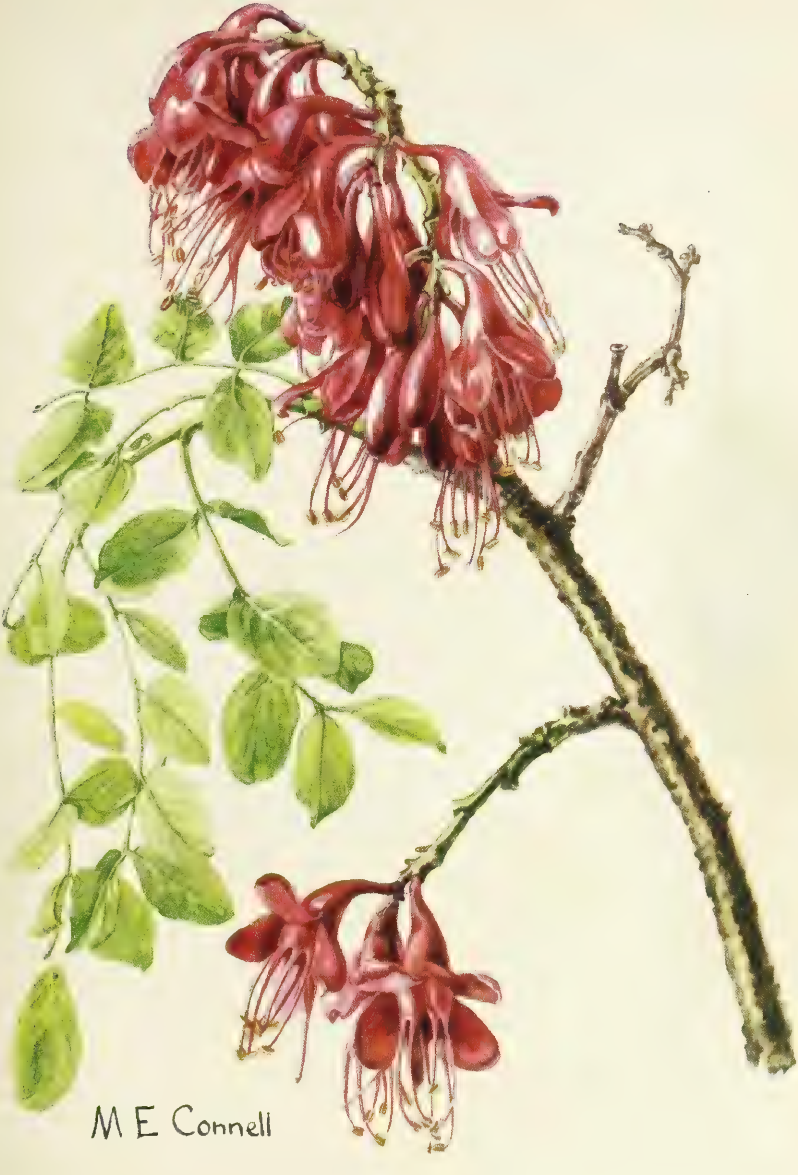


PLATE III.
Schotia brachypetala, Tree Fuchsia or Huilboerboon.

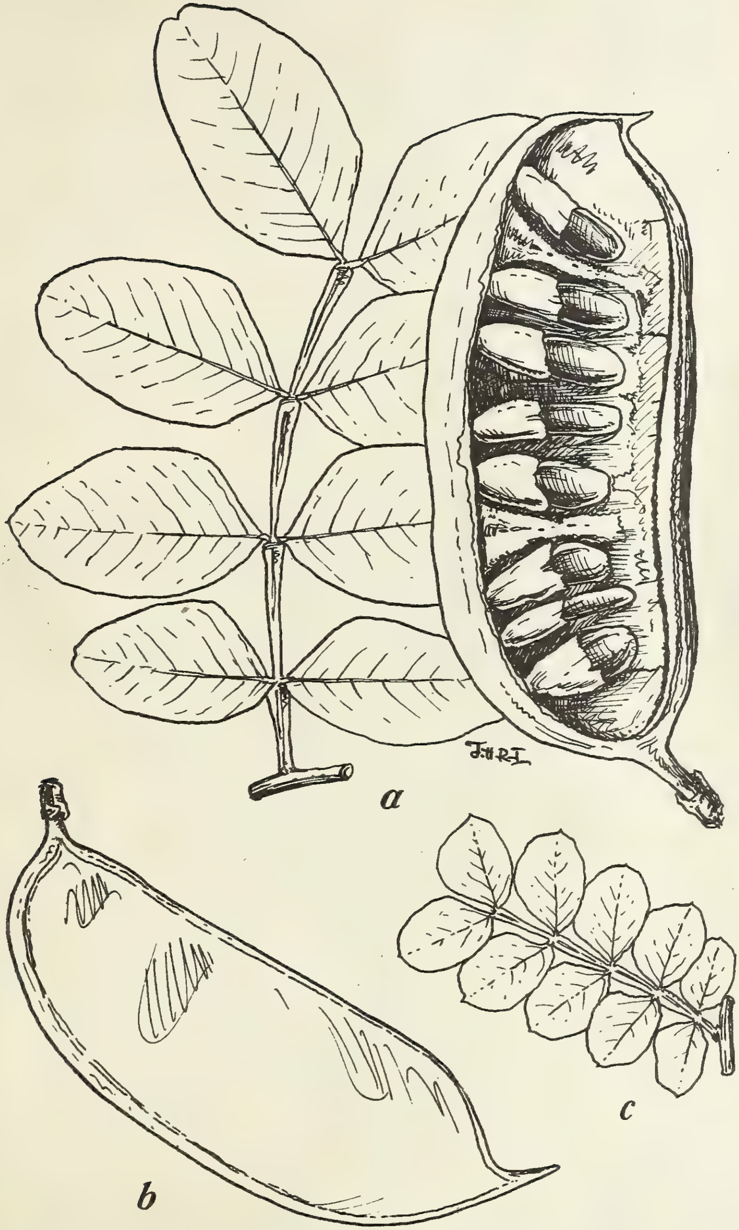


FIG. 63.—a, *Schotia brachypetala,* Tree Fuchsia or Huilboerboon: leaf and open pod; b and c, *Schotia transvaalensis;* Dwarf or Transvaal Boerboon: pod and leaf.

77. Schotia transvaalensis Rolfe. DWARF BOERBOON, TRANSVAAL BOERBOON. Fig. 63b and c.

This species grows as a shrub or slender small tree, 3 to 15 feet high, usually associated with thorn-scrub on brackish flats and stream banks in the neighbourhood of Skukuza. In addition to the Transvaal lowveld, it is found in Portuguese East Africa and Zululand.

For the greater part of the year this species is inconspicuous, but in November or December it produces its blood-red clusters of flowers, resembling the " bottle-brush ". These stand out in striking contrast to the surrounding foliage, but so tangled up is it with thorn-trees and other shrubby plants, that it is often difficult to see which plant is responsible for the display.

Statements that the Transvaal Boerboon grows up to 30 feet high must be regarded as erroneous and due to confusion with the Huilboerboon. The leaves of the Transvaal Boerboon are consistently smaller, the 4 to 6 pairs of leaflets being only ½ to 1 inch long and usually having a sharp pointed tip. Flowering specimens are easily distinguished by the well developed petals in the Transvaal Boerboon, while the pods of the two species are very similar.

Sub-family **Papilionaceae** (Pea and bean sub-family).

As explained earlier, members of this sub-family of the *Leguminosae* all have flowers of the familiar pea and bean shape. Although largely composed of herbaceous members, the sub-family includes also some large and attractive trees. The following genera occurring in the Park are described in this order: *Bolusanthus* (Vanwykshout), *Dalbergia*, *Erythrina* (Kaffirboom), *Lonchocarpus* (Mbandu), *Mundulea* (Corkbush), *Ormocarpum*, *Pseudocadia* (Nhlaru), *Pterocarpus* (Kiaat) and *Abrus* (Luckybean Climber).

78. Bolusanthus speciosus Harms. TREE WISTARIA, ELEPHANTWOOD; VANWYKSHOUT; MPFIMBAHONGONYI (Shangaan); UMHOHLO (Swazi). Plate I (Frontispiece)

The generic name honours Dr. Harry Bolus, founder of the Bolus Herbarium in Capetown. The Shangaan name for the tree implies that it " checks the wildebeest " and although several natives have been questioned about it, they cannot explain its origin.

The Tree Wistaria is undoubtedly one of the most beautiful South African trees and it is common in the Kruger National Park, chiefly southwards from the Letaba River, with some particularly fine specimens up to 30 feet high in the Skukuza-Pretorius Kop area. Some trees may be seen at close quarters in the Pretorius Kop and Malelane Rest Camps. Beyond the borders of the Park it occurs in the Transvaal lowveld, Zululand, Portuguese East Africa, Rhodesia, Nyasaland and Angola.

The graceful, light green, feathery foliage is retained for practically the whole year, being shed in August to September, just before the flowers appear. The Wistaria-like sprays of violet-blue flowers then appear in profusion while the trees are leafless, and are followed shortly by the young leaves. Unfortunately, like so many of our indigenous trees and shrubs, the flowering season is all too short and within two or three weeks there is nothing left of the earlier display.

The longish, narrow and flat grey pods are produced in quantity and the tree is easily raised from seed, though young trees do not always transplant readily. They should be planted in an open, dry situation as

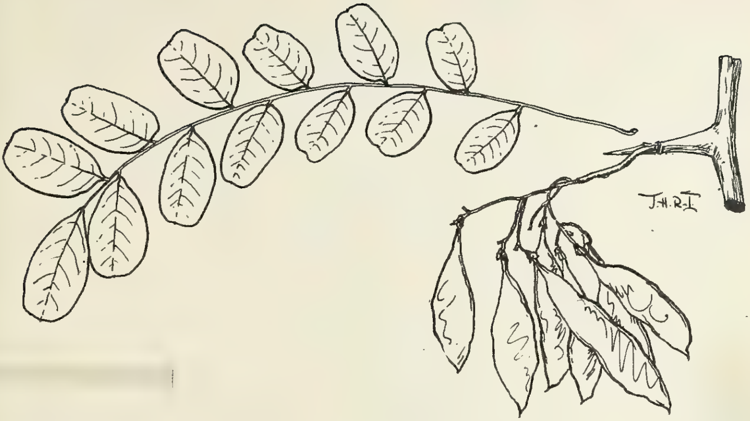


FIG. 64.—*Dalbergia melanoxylon,* African Blackwood or Lowveld Ebony: leaf and cluster of pods.

they do not thrive in partial shade. For a lowveld species, the trees stand a fair degree of frost and can be successfully grown in places such as Pretoria, if the young trees are protected during the winter for the first two or three years.

The bark is black and rough, while the wood is yellowish-white, hard and pliable. It is in demand for wagon spokes, axe-handles and other work where a durable timber is required.

79. Dalbergia melanoxylon Guill. & Perr. ZEBRA-WOOD, AFRICAN BLACKWOOD; DRIEDORING; SHILUTSI, SHIPALATSI (Shangaan). Fig. 64.

The genus commemorates N. Dalberg, a Swedish botanist, who lived from 1730 to 1820.

The African Blackwood is a much-branched, deciduous shrub or small tree with short, spiny branchlets, scattered throughout the Park especially in the environs of Skukuza, and may be seen at Pretorius Kop and Malelane Rest Camps. It is also widespread in tropical east and west Africa.

With the rains in early summer, the bare branches suddenly burst into a profusion of small, white flowers, which attract countless thousands of insects. The leaves which follow are pinnately compound, being made up of 4 to 6 pairs of medium-sized, widely spaced leaflets. The numerous pods each contain several seeds and are elongated, flat and thin-textured.

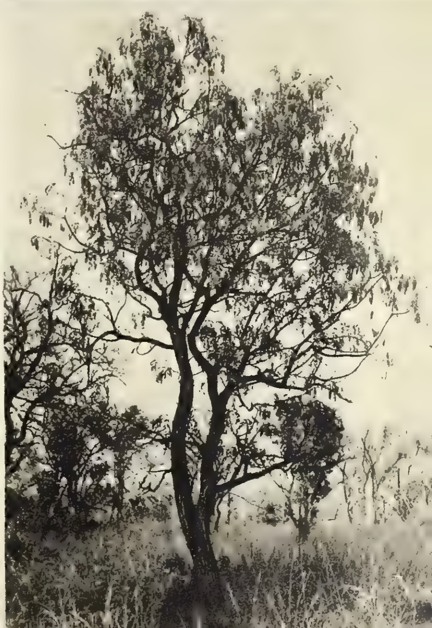


FIG. 65.—*Bolusanthus speciosus,* Tree Wistaria or Vanwykshout, between Skukuza and Pretorius Kop.

The wood (see Fig. 30) is very hard with a striking purple-black heartwood, close-grained and very heavy, from which it derives the popular name Ebony, though it is not related to the true Ebony (see *Diospyros*, page 143). The wood is also pleasantly scented, is used to some extent for ornaments, though the stems are rarely large enough or straight enough and are usually hollow in the centre.

Other species of Dalbergia found in the Park are *D. armata* E. Mey., a woody climber with stout spines on the main stems, and *D. nitidula* Welw., a slender small shrub found in the neighbourhood of Punda Maria.

80. Erythrina caffra Thunb. var. KAFFFIRBOOM; MUVALE, NSISIMBANE (Shangaan); UMSISI (Swazi). Fig. 66.

The name *Erythrina* is derived from the Greek *erythros*, red, in reference to the colour of flowers and seeds of most species.

Some years ago, Dr. Hutchinson of Kew drew attention to certain differences between the Kaffirboom of the Transvaal and typical *Erythrina caffra* of the eastern Cape Province. As a result, he separated a distinct species in the Transvaal, which he named *E. lysistemon*. Before adopting this name, however, it is felt that further research is necessary into the question of whether the differences are sufficient to justify maintaining a separate species. Closer investigation may possibly indicate that the Transvaal form may rather be regarded as a variety of the typical Cape Kaffirboom. The differences between the two are chiefly in the flower characters, as indicated below.

In the typical *E. caffra* of the eastern Cape, the individual flowers are relatively shorter and broader and they tend to stand away from the main flowering axis. The stamens are conspicuously extruded, giving the flower-spike a whiskered appearance. The calyx is comparatively large, being ½ to ¾ of an inch in length. These characters are well illustrated in Sim's *Forest Flora of the Cape Colony*, Plate 53. The flower colour is usually brilliant scarlet, but trees have been recorded with pink, creamy yellow and even white flowers.

The Transvaal Kaffirboom (see Fig. 66) has relatively longer and narrower flowers which are deflexed towards the main flowering axis, giving the flower-spikes the appearance of epaulettes. The stamens are rarely extruded and the calyx is relatively short, being seldom as much as ½ an inch in length. The flower colour does not seem to vary from the familiar brilliant scarlet hue.

The distribution of the two forms appears to overlap along the Natal coast. Here it is interesting to note that trees occur with apparently intermediate floral characteristics, as illustrated in Wood's *Natal Plants*, Vol. VI, Plate 542.

The Transvaal Kaffirboom grows to 20 or 30 feet high and is easily propagated by truncheons or seeds. It grows wild on rocky koppies in the southern part of the Park and has been planted in the Pretorius Kop and Skukuza Rest Camps. Its distribution extends to Rhodesia, Nyasaland and Tanganyika. It is drought resistant, but is sensitive to cold and does not grow or flower satisfactorily when exposed to severe frosts.

The leaves are compound, consisting of three leaflets (a pair of laterals and a terminal leaflet), broad at the base and tapering to the tip and about 2 to 3 inches broad. The branches are thorny, and small thorns sometimes occur along the leaf-stalk. The wood is soft and fibrous and is of little use except as brake blocks. The long, narrow, black

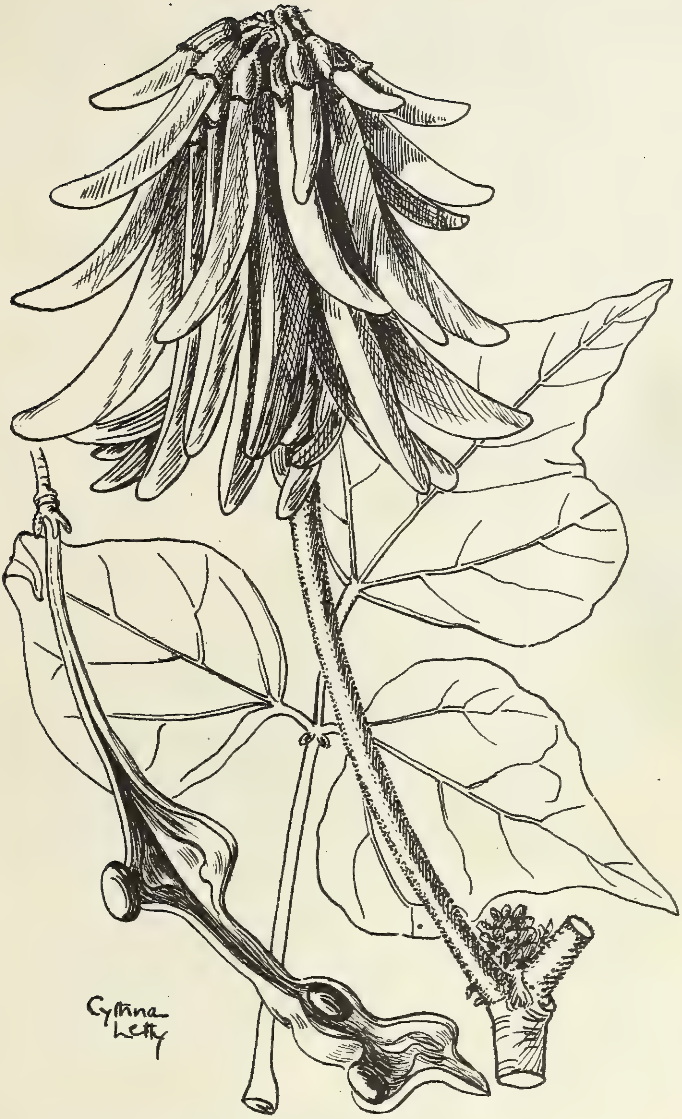


FIG. 66.—*Erythrina caffra*, Kaffirboom: leaf, pod and flower-spike.

pods are constricted between the seeds and burst open exposing several bright red seeds the size of small beans. These seeds contain a poisonous principle which, when injected in small quantities into the blood stream, causes anaesthesia and paralysis and may, on further investigation, prove of use in medicine.

81. Erythrina humeana Spreng. NATAL KAFFIRBOOM. Fig. 67. (=*E. humei* E. Mey.)

This slender, graceful shrub occurs chiefly in the Transkei and Natal, but extends also to the eastern Transvaal and Nyasaland and has been found on the hillside behind Punda Maria Rest Camp.

It rarely exceeds 6 to 10 feet in height. The leaves are made up of three leaflets as in the preceding species and the shape of the leaflets shows a good deal of variation. In the Transkei, the leaflets are more rounded at the apex, while in the Transvaal the leaflets taper to a long point. The flowers resemble *E. caffra* in colour and size, but the flower-spikes are longer and more tapering and the individual flowers are spaced further apart along the flower-stalk.

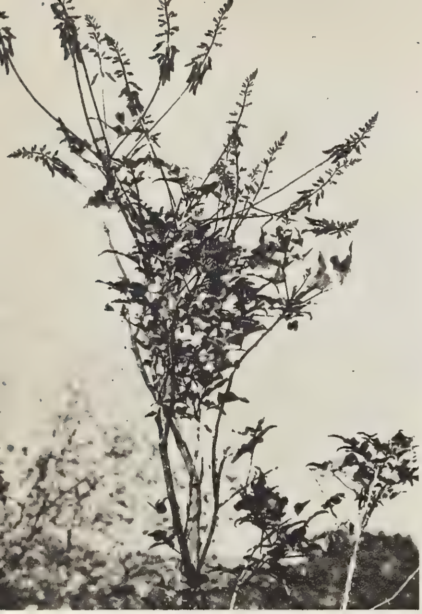


FIG. 67.—*Erythrina humeana*, Natal Kaffirboom, near Punda Maria. [*Photo by Dr. R. A. Dyer.*

82. Erythrina latissima E. Mey. BROAD-LEAVED KAFFIRBOOM.

In this species, the three leaflets comprising the leaf are roundish and very large, up to 10 inches broad, and are sparsely covered with greyish hairs. The young twigs and flower-stalks are also grey-velvety. It is a tree with spreading branches, growing to about 20 feet tall and is rare in the Park, having been observed on Ship Mountain and on rocky koppies near Malelane. In Natal it is common at medium altitudes below the frost line and extends into Rhodesia, where it merges with the very similar species, *E. tomentosa.* The flower clusters are shorter, more compact and less showy than those of the ordinary Kaffirboom.

83. Lonchocarpus capassa Rolfe. MBANDU; APPELBLAAR; MBHANDU, MBHANDZU (Shangaan); SIHOMOHOMO (Swazi). Figs. 68 and 69.

The generic name is derived from the Latin words for *lance fruit*, due to the shape of the pods.

The Mbandu is a deciduous tree of the lowveld, scattered throughout the Park and occurring also in Rhodesia, Ngamiland and Nyasaland. It grows up to 40 feet high on the better soils along rivers in the northern part of the Park, while in the south it is often rather stunted. Well-grown trees may be seen in the Malelane, Skukuza, Letaba, Shingwedzi and Pafuri Rest Camps.

The leaves are pinnately compound, made up of 3 to 5 large oval leaflets—one or two pairs of side leaflets and a large terminal leaflet—grey-green in colour. The colour bears a slight resemblance to apple-tree leaves and this, rather than the shape, must have suggested the common name Appelblaar. Another common name for the tree sometimes encountered is Olifantsoor, though what part of the plant is supposed to resemble an elephant's ear is not known.

Sprays of attractive, mauve-pink, scented flowers of the characteristic pea-flower shape are produced in profusion at the ends of the branches in early summer. These are followed by clusters of drooping, flat pods, greyish-white in colour, about 4 inches long and ¾ of an inch broad, tapering at each end and containing, usually, two flat seeds.

The bark is a mottled greyish colour and the wood is yellowish, intermingled with blue streaks, fairly close-grained and reasonably hard, but it is very liable to borer attack. It is, therefore, of little economic value, being used by the natives as stamping blocks for pounding grain and for little else. It is not even satisfactory for fuel.

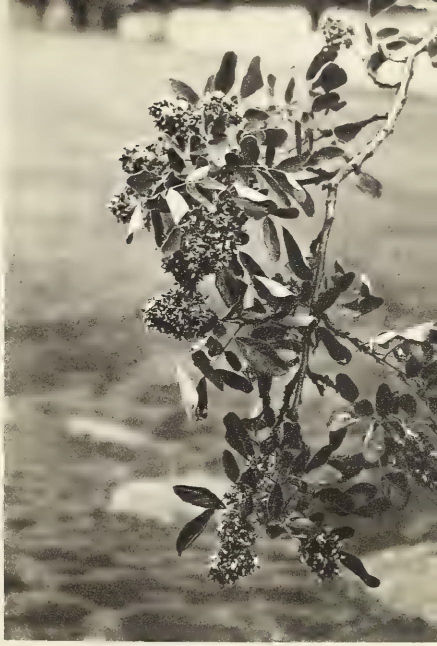


FIG. 68.—*Lonchocarpus capassa*, Mbandu, produces masses of light purple flowers in early summer.

[*Photo by Dr. R. A. Dyer.*

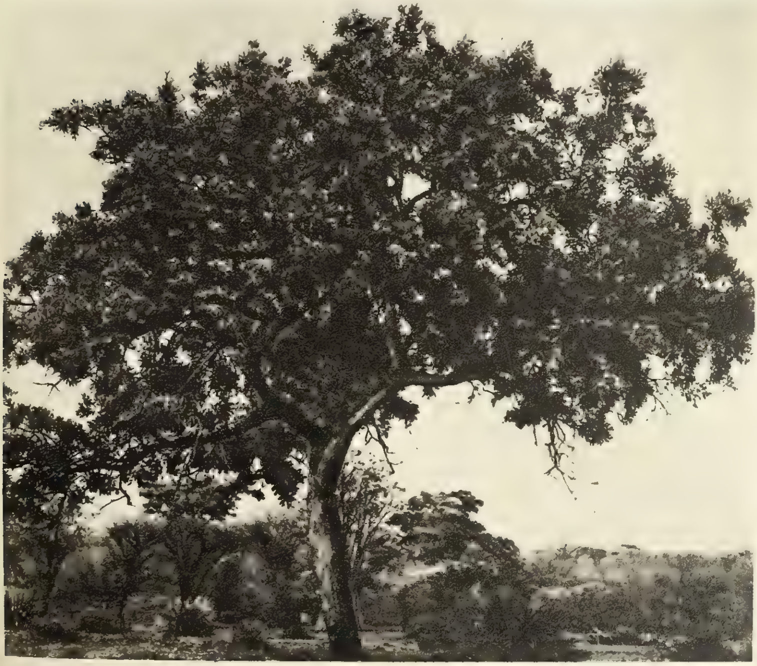


FIG. 69.—*Lonchocarpus capassa*, Mbandu, near Letaba Rest Camp.

[*Photo by Dr. R. A. Dyer.*

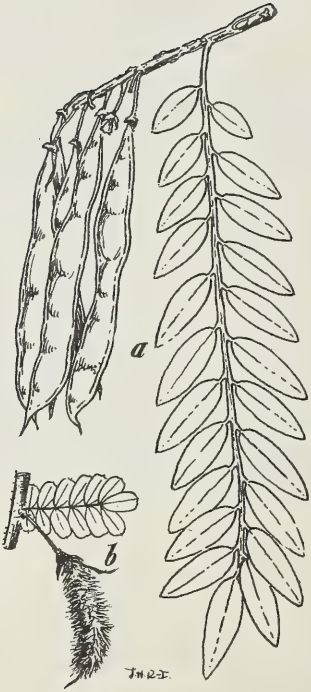


FIG. 70.—a, *Mundulea sericea*, Corkbush: leaf and cluster of pods; b, *Ormocarpum trichocarpum:* leaf and pod.

84. Mundulea sericea (Willd.) Greenway. CORKBUSH, SILVER-BUSH; NTSANDZANDLOPFU (Shangaan); UMPHUKAPHELA (Swazi). Fig. 70a.

An attractive, grey-leaved shrub, found in and around Pretorius Kop Rest Camp and in the Punda Maria area, and occurring commonly in the Transvaal bushveld, especially on the Magaliesberg, Waterberg and Zoutpansberg ranges. It is distributed throughout tropical Africa and Madagascar and shows a good deal of variation.

Both native names refer to the difficulty experienced in breaking the fibrous branches. The Shangaan name is particularly descriptive and may be translated as " resists the elephant ".

The silver-grey leaves are pinnately divided into many narrow leaflets and provide an attractive colour contrast with the sprays of mauve-purple flowers produced at the ends of the branches in early summer. The drooping clusters of long, narrow pods, 3 inches long and ¼ of an inch wide, covered with a greyish felt, persist on the branches until well into winter, or even until the following season. Seeds germinate quite readily if soaked in hot water before sowing, but the young plants are slow to grow and require very well-drained soil.

The bark is light grey, deeply furrowed and corky and contains a substance similar to rotenone, the active insecticidal compound of the Derris plant. The plant is known to the natives as a fish poison, actually killing the fish and not merely stupefying them.

85. Ormocarpum trichocarpum (Taub.) Harms. SHINSITANA (Shangaan); SITSIBANE (Swazi). Fig. 70b.

This is an inconspicuous, slender shrub or small tree with finely divided foliage which gives it the appearance of an *Acacia.* It has no thorns, however, and when in flower, the violet, pea-like flowers distinguish it immediately. Another character which enables one to recognise it is that the small pods, 1 to 1½ inches long and ¼ of an inch wide are covered with stiff, short hairs. It is sparingly branched, rarely exceeding 8 feet in height, but there is usually a well defined main stem with black, roughened bark.

86. Pseudocadia zambesiaca (Bak.) Harms. NYALA TREE; NHLARU. Figs. 71 and 72.

A beautiful, round-topped, evergreen shade tree which occurs along rivers, chiefly in the northern part of the Park. Some of the finest specimens, up to 40 feet or more in height, are found along the Levubu and Limpopo Rivers, for example, in the Pafuri Rest Camp. The dense shade cast by the dark green, pinnate foliage is exceptionally welcome and is the favourite retreat of elephants and the larger antelopes such as nyala, kudu and water buck in the mid-day heat of the lowveld summer.

Sprays of small white flowers are produced at the ends of the branches in early summer. The fruits are unusual for a member of the Legume family, being ovoid in shape and about the size of a sparow's egg. Each fruit consists of a single hard kernel surrounded by a fleshy covering and enclosed in a thin rind which is brown when ripe. The fruits are relished by birds and monkeys and are picked up from the ground by various antelopes. Seeds germinate readily and seedlings are easily raised, but are sensitive to frost.

The tree usually branches freely at ground level so that a single large trunk is seldom found. The wood is whitish-grey and hard, and causes severe irritation to the nose and throat while being worked.

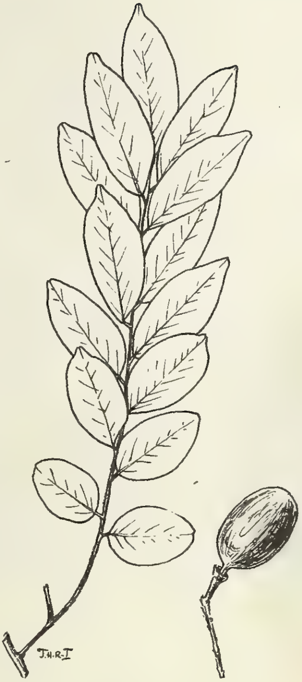


FIG. 71.—*Pseudocadia zambesiaca*. Nhlaru or Nyala Tree: leaf and fruit.

87. Pterocarpus angolensis DC. KIAAT; UMVANGATSI (Swazi). Figs. 73 and 74.

An exceptionally graceful, deciduous tree, 30 to 40 feet high, which is found chiefly in the southern part of the Park, especially around Pretorius Kop, but occurs also near Punda Maria. Beyond the borders of the Park, it extends to the eastern foothills of the Drakensberg range in the Transvaal, and is found also in Portuguese East Africa, Rhodesia, Nyasaland and Angola.

The compound leaves are up to 15 inches long and are made up of 9 to 12 pairs of large leaflets. Sprays of yellow, sweet-scented, pea-like flowers are produced at the ends of the branches in spring, but the flowering season lasts only a week or two. There is no mistaking the disc-like pods, about 3 inches in diameter, with a swollen, bristly centre containing usually two small, hard seeds. These circular pods are often retained long after the leaves have been shed and, when this occurs,

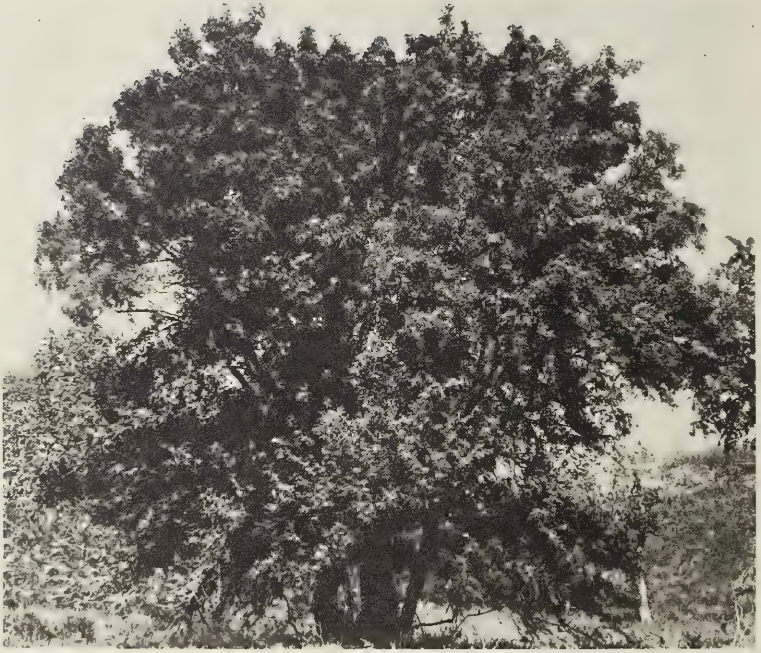


FIG. 72.—*Pseudocadia zambesiaca,* Nhlaru or Nyala Tree, near Pafuri.

the tree may be readily identified from a distance. The name *Pterocarpus* is derived from the Greek words for *wing* and *fruit,* as all species of the genus have pods consisting of a thick, central portion, girded by a thin, fibrous wing.

The bark of the Kiaat is dark grey and slightly roughened. The timber is in demand for furniture, for which purpose it is well suited, being durable and polishing well. The heartwood varies from light to dark brown and contrasts attractively with the pale yellow sapwood. One disadvantage is that the sapwood is susceptible to attack by woodborers. When a living tree is chopped it exudes a blood-red sap and it is to this character that the native name " umVangatsi " refers.

88. Pterocarpus rotundifolius (Sond.) Druce. ROUND-LEAF KIAAT; BLINKBLAARBOOM; NSHELELA, MIYATAHA (Shangaan). Fig. 75.

This is a shrub or small tree with a gregarious nature, often becoming very common as, for example, on the reddish, granitic soil between the Sabie and Sand Rivers, near Skukuza. It is inconspicuous during the tourist season, being completely bare of leaves from about June to October or November.

The leaves are compound, consisting of 3 to 7 large, roundish leaflets, with a shiny, light green colour. About November or December, the plants become covered with masses of yellow, pea-like flowers with a sweet, violet scent. The pods are one or two-seeded, flat and oval in shape, about an inch long and swollen in the middle, but not bristly like

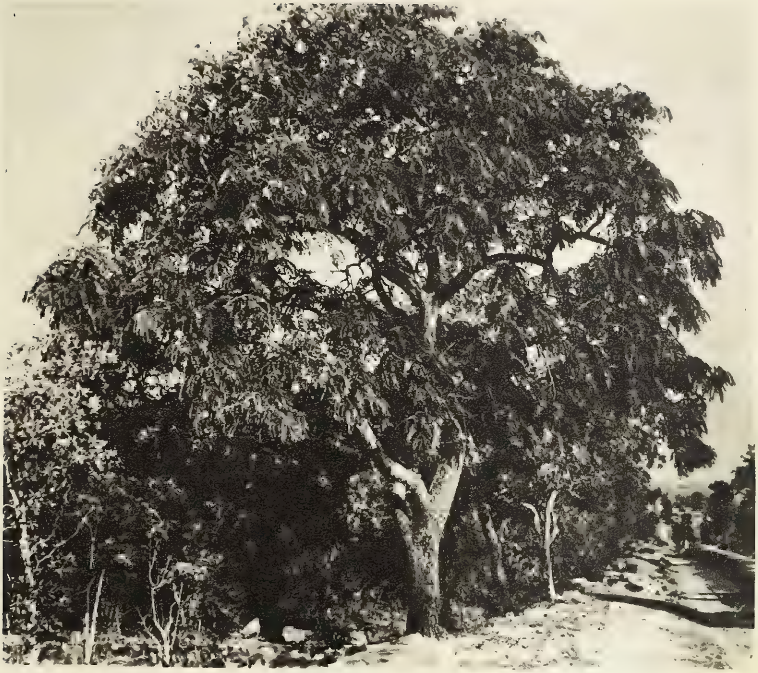


FIG. 73.—*Pterocarpus angolensis,* Kiaat, near Pretorius Kop Gate.

the Kiaat. The timber is yellowish and of poor quality and, in any case, the stems are usually too thin to warrant cutting for their wood.

The Round-leaf Kiaat is characteristic of the poorer, sandy soils of the Transvaal bushveld and is found also in Rhodesia and Nyasaland.

89. Abrus precatorius L. LUCKY-BEAN CLIMBER; NSISANI (Shangaan).

This species is worthy of some mention because the small, hard, red and black seeds are so well known as ornaments and charms. It is a slender, woody creeper with stems ½ to ¾ of an inch thick and with compound, fernlike leaves consisting of 10 to 15 pairs of small, narrow leaflets. The short sprays of pea-like flowers are pale mauve in colour and are followed by the short, black pods which burst open along one side when ripe, exposing 4 to 5 attractive seeds inside.

The Lucky-bean Creeper is scattered throughout the Park and is widely distributed in tropical Africa and Asia. The seeds contain a poison and, if they are powdered and introduced beneath the skin they may produce fatal effects. The whole seeds may be swallowed without harm, probably because the hard seed-coats resist digestion. The roots are used medicinally and as a substitute for liquorice in India.

In addition to the Leguminous trees and shrubs already described, there are smaller and softer shrubs and climbers belonging to such genera as *Canavalia, Crotalaria, Desmodium, Dolichos, Glycine, Indigofera, Rhynchosia* and *Tephrosia*. to mention the more important.

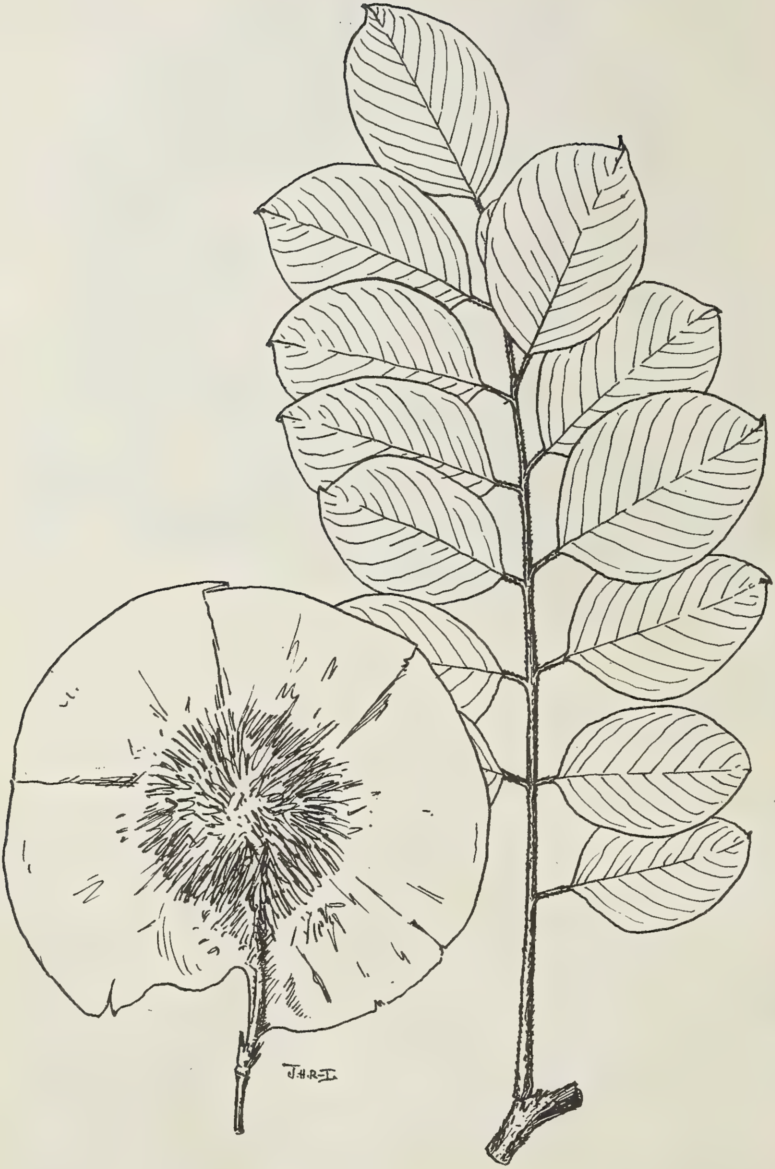


FIG. 74.—*Pterocarpus angolensis,* Kiaat: pod and leaf.

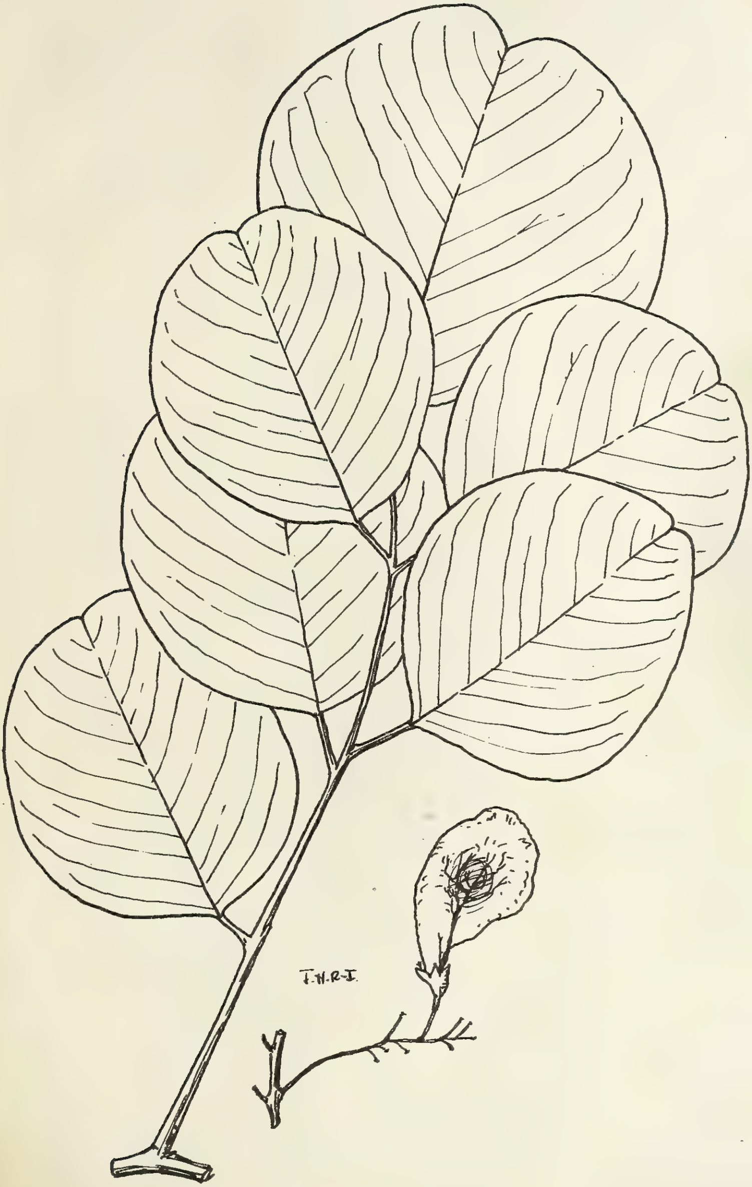


FIG. 75.—*Pterocarpus rotundifolius*, Round-leaf Kiaat: leaf and pod.

ZYGOPHYLLACEAE. Dubbeltjie family (*Tribulus*).

The tree to be discussed under this heading, *Balanites maughamii* (the umNulu or Torchwood), is included by most authorities in this family, but is placed by others in the family *Simarubaceae*. Following the arrangement in *The Genera of South African Flowering Plants* by Dr. E. P. Phillips, it is retained here in the family *Zygophyllaceae*. Probably one of the best known members of the family is the Dubbeltjie or Dubbeltjie-doring (*Tribulus terrestris*), a prostrate herb which is a common weed of cultivation and overgrazed places. Also belonging to this family are several low, shrubby species of *Zygophyllum* in the Karoo, known by such names as Skilpadbossie and Trekbossie.

90. Balanites maughamii Sprague. TORCHWOOD; NNULU (Shangaan); UMNULU (Swazi). Figs. 76 and 77.

This tall, deciduous tree, growing up to 40 or 50 feet high, is frequently seen on the grey, sandy soils southwards from Skukuza, overtopping the mixed Combretum bush with which it is usually associated, while a few specimens have also been found near Punda Maria. A large tree of this species is growing in the centre of the Skukuza Rest Camp and is the favourite nesting place of a large colony of birds. The Torchwood seems to be limited to Portuguese East Africa, the Transvaal, Swaziland and northern Zululand, but a closely related species, *Balanites aegyptiaca,* occurs from east tropical Africa into Egypt. There is another species, *B. australis,* which grows in the low-lying Mopane country north of the Zoutpansberg but has not yet been collected in the Kruger National Park.

The bark of the Torchwood is smooth and grey and the trunk, which is conspicuously fluted or buttressed, usually branches 10 feet or more above the ground. The young branchlets are distinctly zig-zagged, covered with a soft greyish felt and are armed with characteristic strong, forked spines, one prong being longer than the other. The leaves are dark grey-green, velvety when young but becoming smoother with age. They are compound in structure, consisting of two large, oval leaflets 1¼ to 2 inches long.

The flowers are small, yellowish-green in colour and are produced in early summer in inconspicuous sprays. The fruits are like enlarged dates, 1¼ to 1½ inches long and ½ an inch thick, consisting of a large woody kernel covered with a thin fleshy layer, the whole enclosed in a thin rind which is yellowish-brown when ripe. Although monkeys eat this fleshy covering, it is not considered to be edible by the natives.

The seeds of both *Balanites maughamii* and *Balanites aegyptiaca* yield a tasteless and odourless oil said to be suitable for " alimentary, lubricating or manufacturing purposes " (Kew Bulletin, 1913), while an emetic is made from the boiled roots. It has been shown that the fruits of both species, when placed in water, exude a substance which is lethal to certain forms of life, such as snails, tadpoles, small fish and some parasitic organisms, but does not affect others, for example, mosquito larvae. It has been suggested that the planting of these trees beside rivers and dams would control bilharzia. Even if this were so (and it is possible that the trees would not grow near water as they normally inhabit open bush country) such a course could not be advocated because it would automatically eliminate all frogs and fishes as well. There are numerous examples where serious problems have followed an artificial disturbance of the balance of nature and the removal of natural enemies of mosquitoes and flies might well have unpleasant consequences.

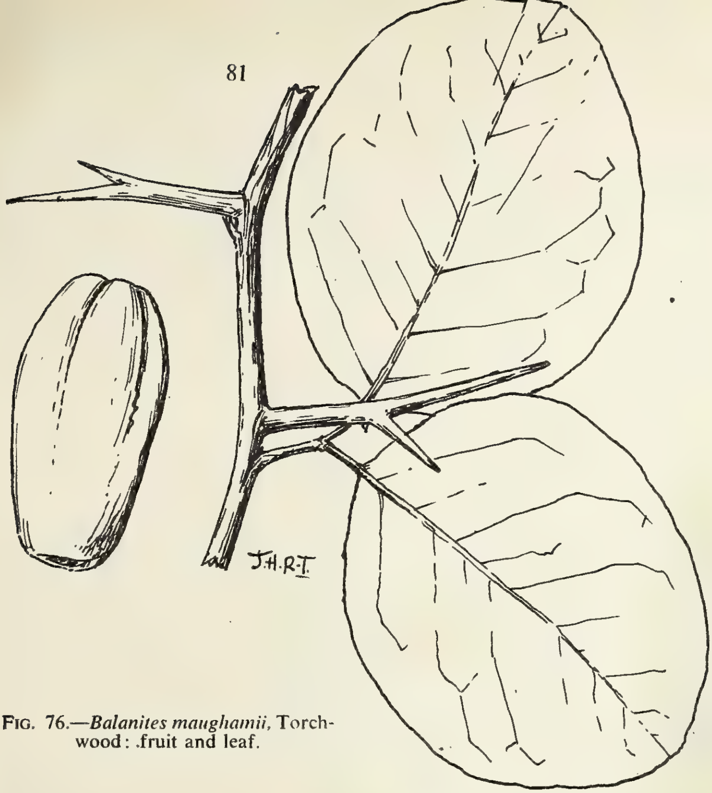


FIG. 76.—*Balanites maughamii,* Torchwood: fruit and leaf.

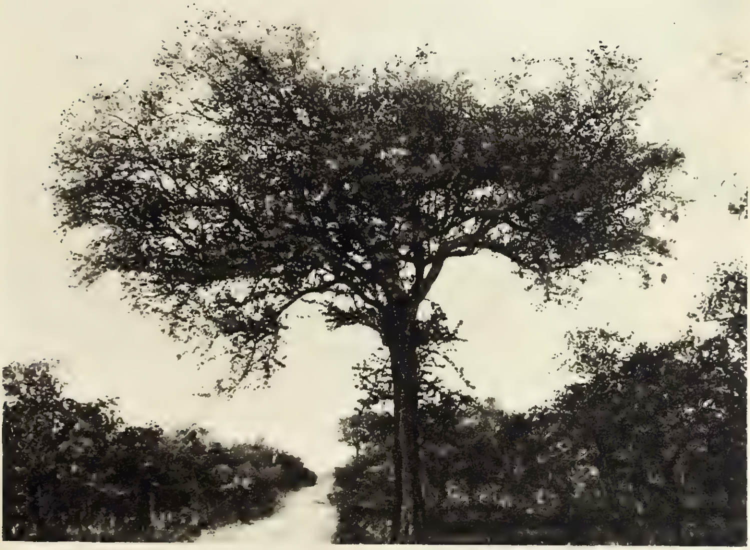


FIG. 77.—*Balanites maughamii,* Torchwood, near Kemp's Cottage.

RUTACEAE. Citrus family.

This family, which includes the large group of cultivated citrus fruits, is made up mainly of trees and shrubs with compound, aromatic leaves. Well known South African examples are the Buchu (*Barosma*) and the Cape Chestnut (*Calodendrum capense*). Several unimportant species are found in the Kruger National Park and two of them are briefly described below.

91. **Fagara humilis** E. A. Bruce.* LOWVELD LEMONTHORN; MANUNGWANA (Shangaan).

This variety of Lemon-thorn, which proved to be an unnamed species, is scattered throughout the Park, but is never common or conspicuous. It is a deciduous shrub, branching freely from ground level, and reaching 3 to 5 feet in height. The strong ascending branches have a whitish bark and are armed with many hooked thorns. The leaves are pinnately divided and emit a characteristic, citrus-like scent when crushed. Small white flowers are produced in slender tassels towards the ends of the branches in early summer together with the young leaves. The natives use an infusion of the leaves as a treatment for toothache.

92. **Clausena anisata** Hook f.

A deciduous shrub or small tree with pinnate leaves which have an unpleasant smell. According to Burtt Davy, it is referred to by Modjadje's people as Soobapeeri, which is interpreted as meaning " stinks so that the hyena would not come near it ".

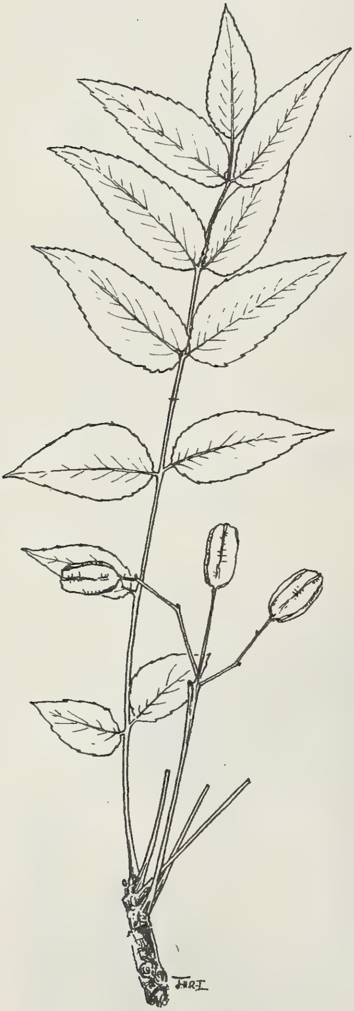


FIG. 78.—*Kirkia acuminata*, White Seringa: twig with leaf and fruits. × ¾.

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* *Bothalia*, Vol. 6, pt. 1 (1951).

SIMARUBACEAE. Tree of Heaven family.

A small family of about 100 species distributed in the tropics of both hemispheres. It includes the Tree of Heaven (*Ailanthus*), which is used to some extent as an ornamental tree in parks. Only two species, both from the same genus, are recorded in South Africa, namely, *Kirkia acuminata* and *K. wilmsii*, and both are found in the Kruger National Park.

93. Kirkia acuminata Oliv. White Seringa; Mvumayila (Shangaan). Figs. 78 and 79.

The genus *Kirkia* is named in honour of Sir John Kirk, famous explorer and naturalist and companion of David Livingstone. The native name for this species may be translated as "celestial hum"

The White Seringa is one of the most graceful trees in the lowveld, inhabiting stony slopes near Pafuri and extending on rocky situations as far south as the Olifants River. It is a common tree on the red, granitic, sandy flats in the Messina-Dongola area, where it attains to a large size. Further afield, it is found in Bechuanaland, Rhodesia, Portuguese East Africa and Nyasaland.

It is a round-topped, leafy, deciduous tree, growing up to 30 feet in height, with a smooth, grey trunk, often producing the first branches 6 to 8 feet above the ground. The long pinnate leaves have a feathery appearance and develop beautiful yellow and reddish tints in autumn. Visitors travelling north of the Olifants River in early June will still see these attractive trees on the skyline of low ridges and koppies but, for the greater part of the tourist season, they are completely leafless.

Flowers are very small, whitish in colour, and are produced in slender sprays at the ends of the branches, and are followed by the small, 4-angled, hard, capsular fruits. Trees may be propagated by pole-cuttings or from

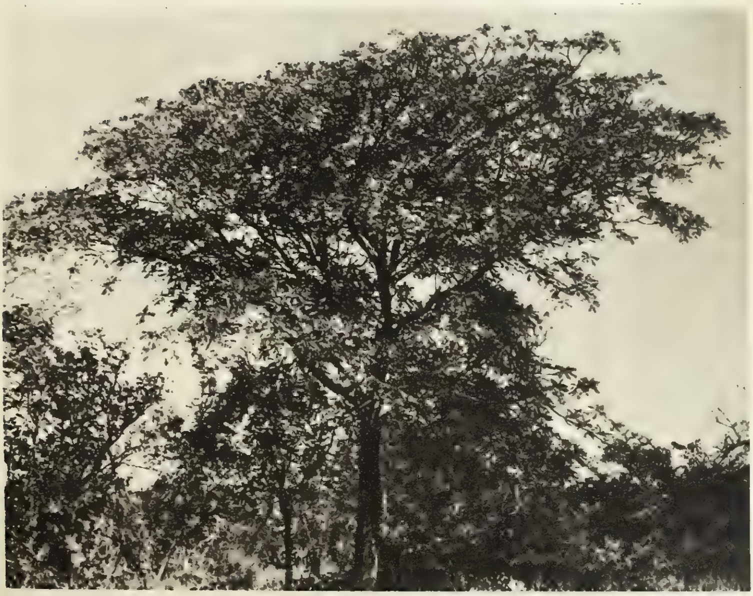

Fig. 79.—*Kirkia acuminata*, White Seringa, between Punda Maria and Pafuri.

seed and the species is worthy of more extensive planting for ornamental purposes in the warmer areas on account of its drought resistance and attractive foliage.

The timber has a handsome, mottled, light and dark brown colour with a rather coarse grain and, although used for furniture, the wood is very susceptible to borers and is not durable.

94. Kirkia wilmsii Engl. MOUNTAIN SERINGA, WILD PEPPER-TREE; SLAPLOOT. Fig. 80.

As one of the popular names suggests, this tree resembles the cultivated Pepper-tree, *Schinus molle,* in its round, leafy shape and finely divided, pinnate leaves. It has been found on rocky koppies near Malelane, but is not visible from tourist routes in the Park. Along the Great North Road it may be seen a few miles north of Warmbaths, and is common on the rocky, dolomitic slopes beyond Potgietersrust. The species appears to be confined to the Transvaal and, in addition to the above localities, it occurs in Sekukuniland and in the Barberton, Pretoria, Pietersburg and Zoutpansberg Districts.

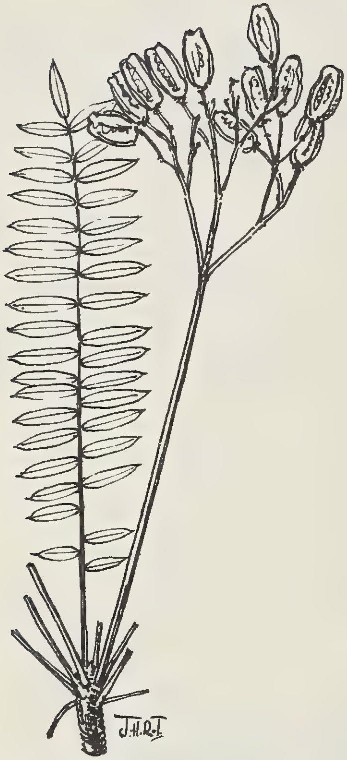

FIG. 80.—*Kirkia wilmsii,* Mountain Seringa.

It does not form a long straight trunk like the White Seringa, and the round crown is produced near ground level, rarely exceeding 15 or 20 feet in height. In the early summer, the light green leaves are produced in dense tufts at the ends of the branches and they develop attractive, autumn tints before being shed.

The flowers and fruits are similar to those of the White Seringa and the tree may also be grown easily from seed. The wood is of little value, being light in weight, straight and coarse grained and of a greyish-white colour. The thin stems and roots are used by the natives of Sekukuniland as a source of twine.

BURSERACEAE. Myrrh family.

The trees and shrubs of this family are noted for the resins and oils contained in the stems, yielding the balsams, myrrh and frankincense of ancient times. The largest and most important genus of the family is *Commiphora,* with about 140 species, several of which are found in the warmer parts of South Africa, and it is of interest to note that the name *Commiphora* is derived from the Greek words for *gum bearing.*

Species of *Commiphora* (Corkwood or Kanniedood) grow in a variety of habitats, from the driest bush country to forest conditions. Most of those that grow under semi-desert conditions have developed abbreviated, spiny branchlets. The soft-wooded stems show great resistance to drying out and are easily grown from pole-cuttings, thus suggesting the popular name Kanniedood (Never-die).

Several north African and Asiatic species are " bled " periodically to obtain the fragrant, resinous substance known as myrrh, used in medicine and as incense, while the " Balm of Gilead " is said to have been collected from *Commiphora opobalsam*, a native of Nubia and Arabia. The resin of one South African species has been submitted to preliminary tests, but the results have not proved promising.

In the deserts of Somaliland and northern Kenya, some species of *Commiphora* are extensively browsed by camels, but the South African species appear to be avoided by grazing animals except, possibly, in South West Africa, where goats are said to browse on *C. pyracanthoides*.

Ten species of *Commiphora* have been recorded in the Kruger National Park and 6 of these are described in the following order: *C. betschuanica, C. edulis, C. glandulosa, C. mollis, C. viminea* and *C. neglecta*. Of the remaining 4 species, *C. calciicola* and *C. pyracanthoides* are low shrubs, widely distributed throughout the Park, while *C. harveyi* and *C. marlothii* are trees inhabiting less accessible parts of the Park, *C. harveyi* in the south and *C. marlothii* in the extreme north near Pafuri.

All species are deciduous, the leaves turning pale yellow shades before being shed and the trees remain leafless for the greater part of the tourist season. The leaves, when available for study, show a most interesting range of shapes, as follows:—

Simple leaves: *C. glandulosa, C. pyracanthoides* and *C. viminea*.
Trifoliolate leaves: *C. betschuanica, C. calciicola* and *C. neglecta*.
Pinnate leaves: *C. edulis, C. harveyi, C. marlothii* and *C. mollis*.

In addition, the bark shows characteristic mottlings and markings in some species, while in others it peels in thin, papery strips, and these characters will also assist in identifying the trees.

95. **Commiphora betschuanica** Engl. Fig. 83e.

A small deciduous tree about 20 feet high, scattered in the southern part of the Park and rare near Klopperfontein in the north. Beyond the borders of the Park, it is found in Bechuanaland and in the dry, bush country of central, northern and eastern Transvaal and into northern Zululand.

The trunk is brownish-green and mottled due to the bark peeling in small strips and irregular patches, giving it a diseased appearance. The canopy is twiggy and untidy and the small branchlets are tipped with hard, sharp points. The flowers are small and they are produced in small, stalkless clusters before the leaves appear. The fruits are oval, pointed at the tip, less than ½ an inch long, consisting of a single large seed with a thin fleshy covering.

The leaves in this species are trifoliolate on slender leaf-stalks and the margins of the leaves are irregular (crenate-dentate).

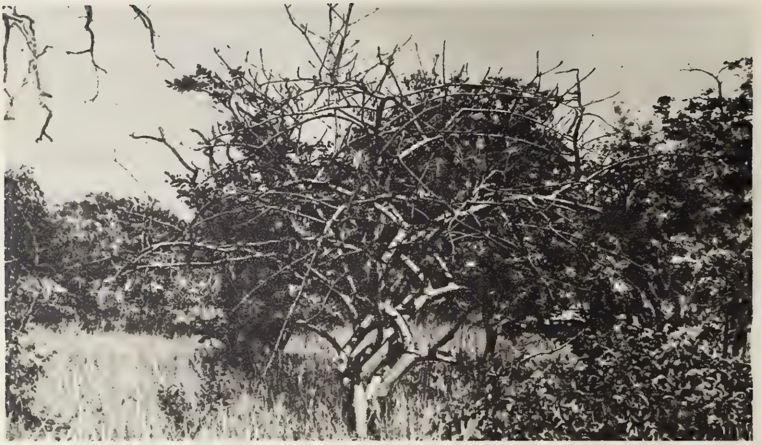

FIG. 81.—*Commiphora edulis*

96. Commiphora edulis (Kl.) Engl. SHIPONDOTI (Shangaan). Figs. 81 and 83b.

A low tree or shrub, often several-stemmed, with smooth, white, twisted trunks which stand out clearly, though the trees are leafless for the entire tourist season. It is found in the extreme north of the Park, being common on rocky ridges near Pafuri, and occurs also in the Messina area, Portuguese East Africa, Bechuanaland, Southern Rhodesia and Nyasaland.

The leaves are pinnate, with two or three pairs of lateral leaflets and a larger terminal leaflet. The individual leaflets are elliptical, about 1½ to 2 inches long and 1 inch broad, and are covered with silky hairs. This species is one of the first of the lowveld trees to shed its leaves in autumn.

The small flowers are produced before the leaves in October or November on slender, branched stalks, the male and female flowers being borne on different trees. The fruits are ovoid and reddish when ripe and are larger than other South African Commiphora fruits, being up to ¾ of an inch long. Like the other Commiphoras, the fruit consists of a single seed with a soft fleshy covering. The specific name *edulis* suggests that the fruits are edible, but the local natives do not confirm this. It has, however, been recorded that the fruits of some Commiphoras in tropical Africa are eaten by birds and rodents.

97. Commiphora glandulosa Schinz. CORKWOOD; KANNIEDOOD; SHIFATI (Shangaan). Fig. 83d.

A round-topped tree growing up to 20 feet in height, though usually not much exceeding 10 or 12 feet, branching well above the ground, with a somewhat drooping, umbrella-shaped canopy. It is easily grown from pole cuttings and has been propagated as living fence posts round the Olifants River Rest Camp, while a tree may be seen at close quarters in the Gorge Rest Camp. It is scattered throughout the Park north of the Sabi River, its distribution extending from South West Africa, through

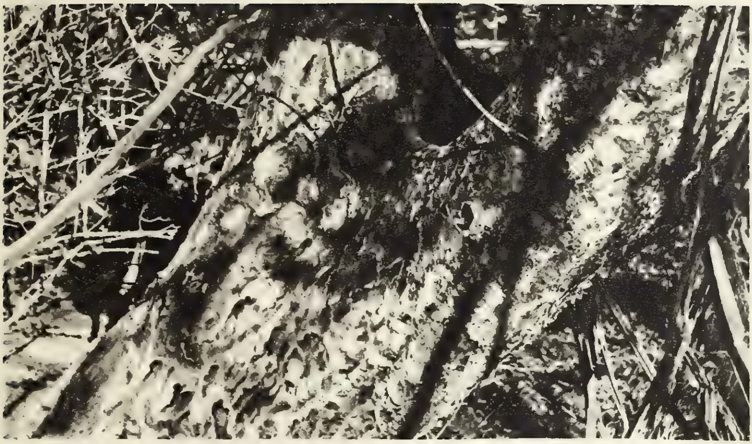

FIG. 82.—*Commiphora neglecta*, showing its patchy, peeling bark.

Bechuanaland to north-western, northern and eastern Transvaal and into northern Zululand.

The leaves are simple (not compound as in the previous two species), bright green in colour and tend to be clustered on abbreviated branchlets on very short leaf-stalks. The leafy branches are very similar to those of *C. pyracanthoides* and the two species are easily confused in the Herbarium but, in the field, they may be distinguished by the fact that *C. pyracanthoides* grows as a spreading shrub up to 4 or 5 feet high and never as a distinct tree. The fruits of both species are small, ovoid, about the size of a green pea, though reddish brown when ripe. When the fruits are ripe, the fleshy covering may be easily split apart in two halves exposing the black seed with a red aril covering it partly at the base and extending in four slender " fingers ", producing an intriguing colour pattern.

The small flowers appear clustered on the branches before the new leaves are produced in October or November. *Commiphora glandulosa* has a sickly-looking, green trunk, with the bark peeling in small, papery strips, making it similar in appearance to *C. neglecta* (No. 100).

98. Commiphora mollis Engl. KUHUTI, SHISENGA (Shangaan). Fig. 83c.
(= *C. cinerea* Engl.)

A larger tree than the three previous species, growing to 25 feet in height with a round, much-branched crown. It is an attractive, leafy tree in summer and autumn, when the leaves turn pale yellow shades before being shed, but for the greater part of the tourist season it is bare and inconspicuous. It is scattered throughout the Park, being particularly common around Skukuza, while a few trees may be seen in the Punda Maria Rest Camp, near the restaurant. It is a widespread and variable species and has been described under several specific names. If all the variations are included, it may be described as occurring in east and west tropical Africa and as far south as South West Africa, Bechuanaland, north-western and eastern Transvaal and Portuguese East Africa.

The leaves are pinnately compound, with two to four pairs of leaflets and a terminal leaflet, grey-green in colour and covered with silky hairs, the individual leaflets being oval in shape, about 1 inch long and ½ an inch wide, with entire margins. The branches are not spine-tipped as in some other Commiphoras. The small, pinkish flowers are produced on slender, branched flower-stalks at about the same time as the young leaves in October or November. The fruits which follow are round and green in colour and are about the size of a Cape gooseberry and, as before, consist of a single seed with a thin fleshy covering. The bark is brown and is characteristically mottled with irregular, circular patches of lighter colour about the size of half-crowns.

99. Commiphora viminea Burtt Davy. Fig. 83f.

Only one tree of this species, to my knowledge, can be seen from the tourist roads in the Park and this solitary specimen is on the southern road loop from Pafuri Rest Camp to the Portuguese border, between 2 and 3 miles west of the border. Its distribution appears to be limited to the northern Transvaal, north of the Zoutpansberg Range and it is frequently encountered in the Messina-Dongola area.

The striking character which distinguishes this species from other South African Commiphoras is its bark, which shows black, warty strips and patches on a greyish background. The leaves are simple with very short leaf-stalks, closely resembling those of *C. glandulosa* in shape, but the leaves of *C. viminea* have a distinctly greyish (glaucous) bloom. The tree grows to about 12 or 15 feet high with a twiggy crown like *C. betschuanica* or *C. glandulosa* and the Shangaans apply the name " Shifati " to all three species. The flowers and fruits are very similar to those of *C. glandulosa.*

100. Commiphora neglecta Verdoorn.* SHISENGA (Shangaan). Figs. 82 and 83a.

A previously unnamed species of *Commiphora,* which has also been collected in Zululand and in the Waterberg District of the Transvaal, occurs in the southern part of the Kruger National Park. It is nowhere very common, though several specimens may be seen on the Lower Sabie road, about 12 to 15 miles from Skukuza. It grows 10 to 15 feet high and has a thick, greenish trunk, often branching near ground level. The bark tends to peel in small, papery strips, producing a sickly, mottled appearance.

The bright green leaves are smooth and trifoliolate on longish, slender leaf-stalks while the small branchlets are usually abbreviated and spine-tipped, giving the crown a twiggy appearance. In autumn the leaves turn pale yellow before being shed. Flowers are very small, as in the other Commiphoras, and are produced on short stalks before the young leaves. The fruits are roundish like small gooseberries and are bright red when ripe. As in *C. glandulosa* and certain other Commiphoras, the fleshy covering of the ripe fruit can be split apart easily in two halves revealing the black seed with a red, claw-like aril at one end.

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* *Bothalia,* Vol. 6, pt. 1 (1951).

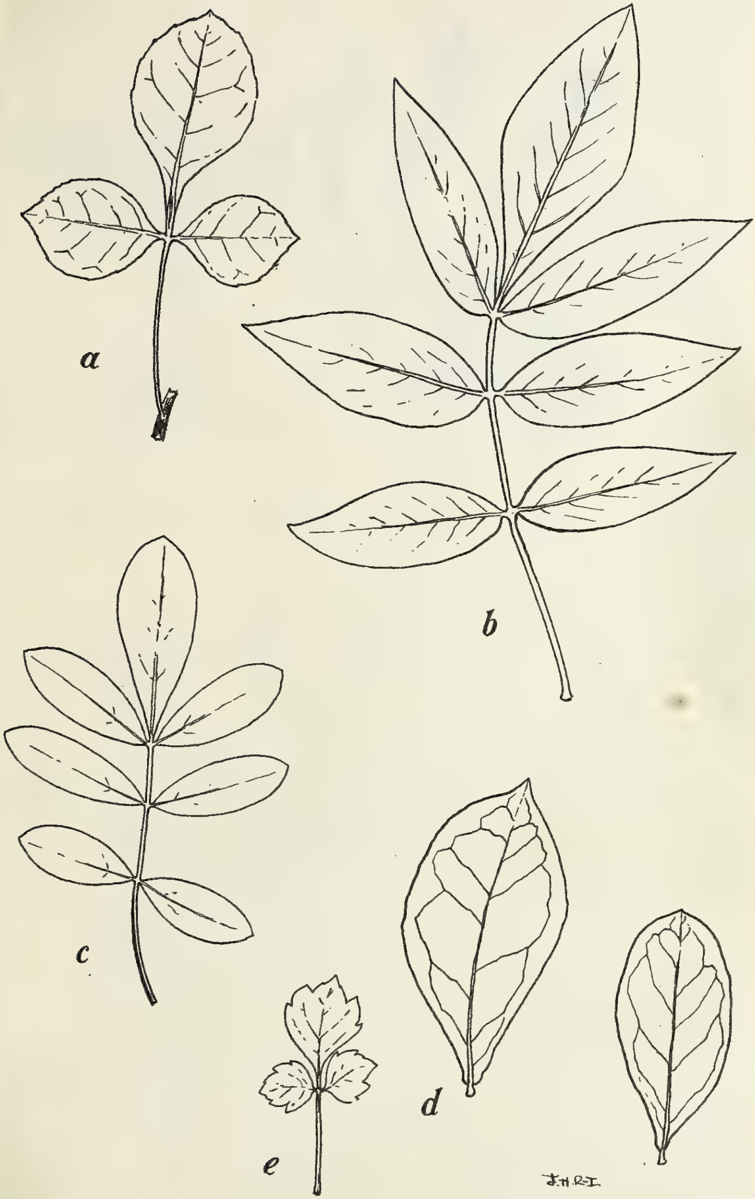


Fig. 83.—Leaves of Corkwood species: a, *Commiphora neglecta;* b, *C. edulis;* c, *C. mollis;* d, *C. glandulosa;* e, *C. betschuanica;* f, *C. viminea.*

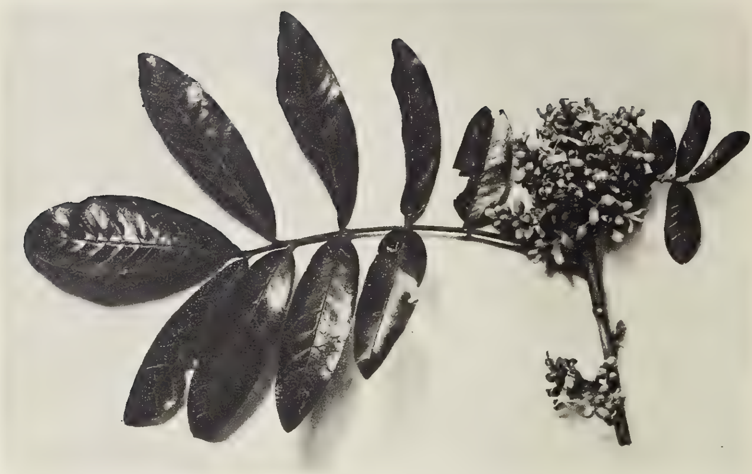


FIG. 84.—*Trichilia emetica*, Mkuhlu or Natal Mahogany: flowering branch, ×½. [*Photo by H. King.*

MELIACEAE. Mahogany and Sneezewood family.

Some excellent timber trees are included in this family, for example, the West Indian Mahogany (*Swietenia*), African Mahoganies (*Khaya, Pseudocedrela* and *Entandrophragma*), Sneezewood (*Ptaeroxylon*), Natal Mahogany (*Trichilia emetica*) etc. The members of this family found in the Kruger National Park are dealt with in the following order: *Trichilia emetica, Ekebergia meyeri, Entandrophragma caudatum, Ptaeroxylon obliquum* and *Turraea oblancifolia.*

Another well known member of this family is the cultivated Seringa (*Melia azedarach*), a native of Asia, which is planted as an ornamental tree in the Skukuza, Crocodile Bridge and Malelane Rest Camps. It is inclined to spread easily by seed and a group of trees has already become established on the banks of the Crocodile River, near Malelane, presumably from seed brought down by the river.

101. Trichilia emetica Vahl. NATAL MAHOGANY, THUNDER-TREE; ROOI-ESSENHOUT; NKUHLU (Shangaan). Figs. 84 and 85.

The name *Trichilia* is derived from the Greek, meaning *by threes,* probably in reference to the three-lobed capsular fruits.

The Natal Mahogany is one of the outstanding shade trees of the Kruger National Park, growing up to 30 or 40 feet or more in height with a round spreading crown of dark, evergreen foliage. The species is usually found on alluivial soil along the larger rivers but, in the Pretorius Kop area, where the rainfall is higher, it is able to forsake the rivers and grows in open woodland on the granite formation around the Rest Camp. Naturally occurring trees may be seen in the Pafuri and Pretorius Kop Rest Camps, while trees have been planted in the Skukuza, Satara and Olifants River Rest Camps. It is a widespread species, usually associated with warm, forest conditions, distributed from tropical east and west Africa into Portuguese East Africa, the Transvaal lowveld, Natal and the Transkei.

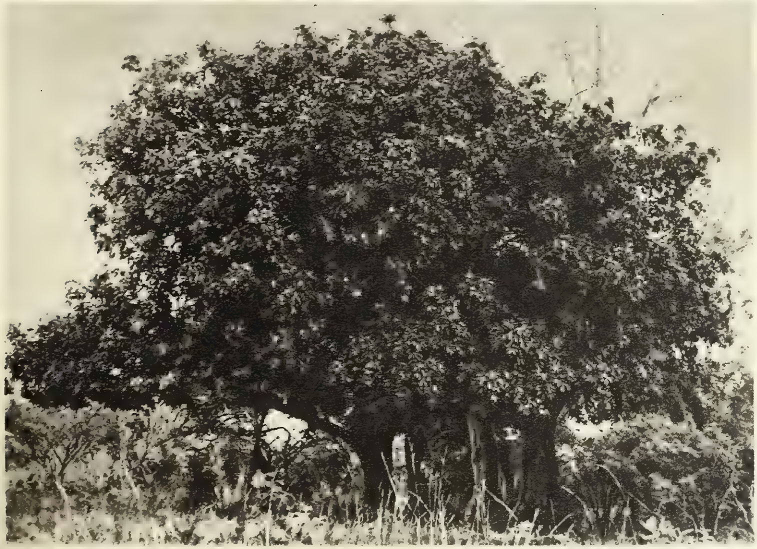
The dark green, glossy, pinnate leaves are made up of 7 to 11 leaflets, arranged in 3 to 5 pairs, with a terminal leaflet. The individual leaflets are longish eliptical, up to 4 inches long and about 1½ inches broad, rounded at the ends. Small, bell-shaped, creamy-white flowers, which are sweetly scented, are produced in short sprays at the ends of the branches in summer. The fruits are round, hard capsules which burst open showing 3 compartments, each containing two long-ovoid seeds, resembling a large bean, black in colour and almost completely covered with a red layer, or aril.

The Natal Mahogany is a tree of many uses which, combined with its value as a shade tree, make it one of the most useful trees in the lowveld. Watt and Brandwijk state that the bark contains a bitter principle which is extracted by the natives and used as an emetic and purgative. A hot infusion of the leaf is said to be used for bruises, while leaves are placed in their bedding as a soporific. Miss E. D. Earthy reports that the women of Gazaland prepare a cosmetic oil from the seed kernel, an edible oil from the white pulp surrounding the kernel and candles from the kernel remains.

At the beginning of the century, seeds were collected in commercial quantities by the natives of Portuguese East Africa and exported under the name of Mafura or Mafurreira nuts. The oil obtained is, however, dark in colour and of low quality, while the cake remaining after extraction of the oil contains a bitter substance which renders it unsuitable for stock feed.

A useful timber, light in weight and pinkish-brown in colour is obtained from the tree, but it is softer and less durable than the tropical African Mahogany.

FIG. 85.—*Trichilia emetica,* Mkuhlu or Natal Mahogany, near Pretorius Kop.



102. Ekebergia meyeri Presl. DOGPLUM, MOUNTAIN ASH; ESSENHOUT.

This species is rare in the Park, occurring usually on well wooded stream banks. The pinnate leaves are longer than those of the Natal Mahogany and the individual leaflets taper to a distinct point. It is also an attractive evergreen tree and some fine specimens may be seen near Louis Trichardt, on the road to Punda Maria—relics of the forest which, no doubt, once extended down to the foothills of the Zoutpansberg range. The Mountain Ash is very difficult to distinguish from the closely related Cape Ash, *E. capensis*.

103. Entandrophragma caudatum Sprague. MOUNTAIN MAHOGANY; NDJOUDJOU (Shangaan). Figs. 87 and 108b.

An interesting and little known species occurring on the Zoutpansberg Range and also in Rhodesia and Nyasaland. In the Kruger National Park, it is found north of Punda Maria, where it is often the largest tree, growing to 40 or 50 feet in height. It has a straight trunk, branching 10 to 15 feet above the ground, while the bark is smooth, light grey and mottled like the Marula.

The pinnate leaves are up to 12 inches long and are made up of many pairs of tapering leaflets, and they are shed towards the end of summer. The fruits are hard and sub-cylindrical in shape, about 5 inches in length [Fig. 108 (*b*)]. They usually remain on the tree after the leaves are shed and eventually break, the five woody valves recurving and discharging a number of large, winged seeds.

The timber is heavy and reddish-brown in colour with an attractive grain of the Mahogany type and is suitable for making furniture.

104. Ptaeroxylon obliquum (Thunb.) Radlk. SNEEZEWOOD.

The Sneezewood grows to a large tree in the forests of Natal and eastern Cape Province but, in the Kruger National Park, it does not reach timber size. Here it grows as a graceful small shrub on rocky koppies, chiefly north of the Olifants River.

105. Turraea oblancifolia Bremek.

This is a shrub about 3 or 4 feet high with pretty white flowers. It has been recorded in the dry bush country between Pretorius Kop and Skukuza. Another species, *T. randii* Bak. f. has been collected near Pretorius Kop Gate.

POLYGALACEAE. Polygala family.

106. Securidaca longipedunculata Fresn. VIOLET TREE; KRINKHOUT; TSATSU (Shangaan). Fig. 86.

A deciduous shrub or small tree growing up to 20 feet in height, distributed from tropical east and west Africa southwards to the Transvaal bushveld. In the Kruger National Park only a few trees have been seen on the deep, white, sandy soils near Punda Maria.

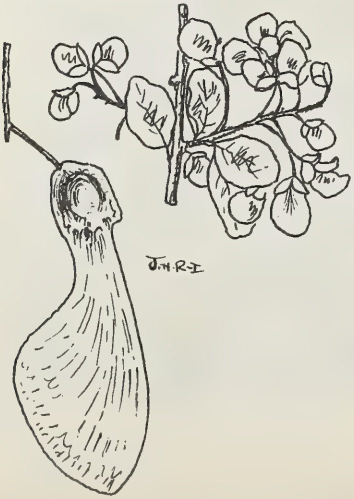


FIG. 86.—*Securidaca longipedunculata*, Violet Tree. × ¾.

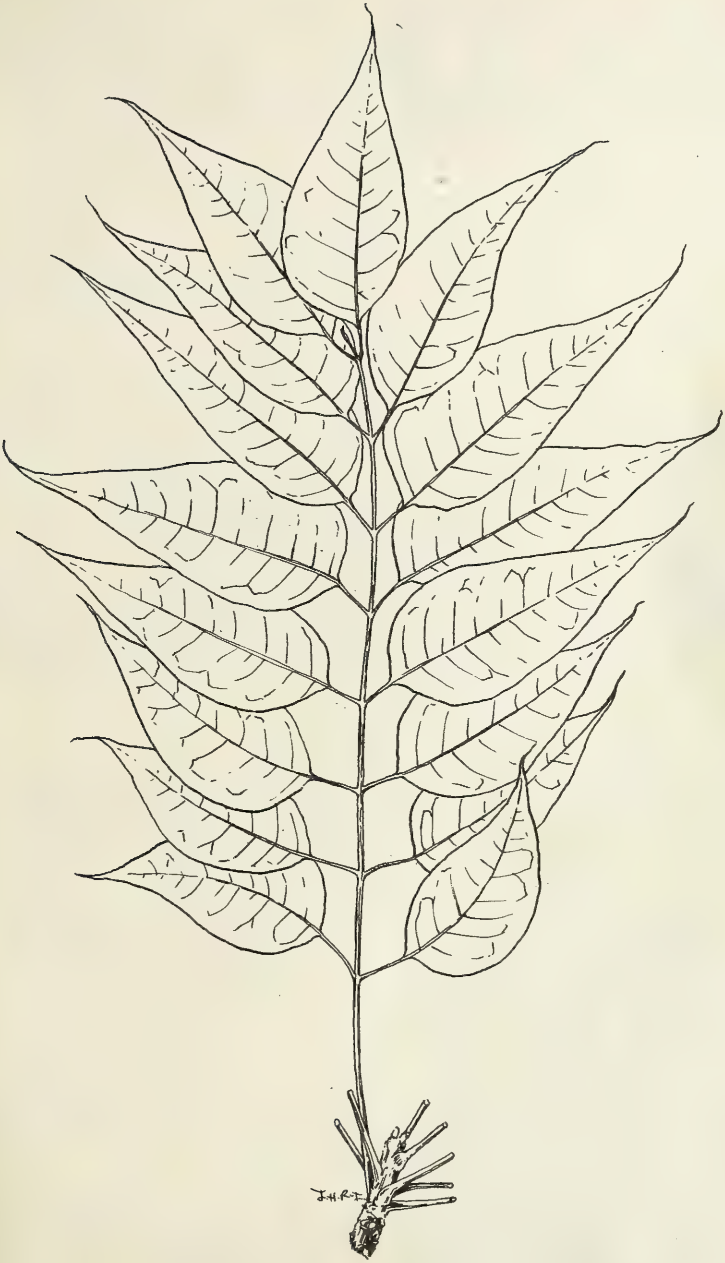


FIG. 87.—*Entandrophragma caudatum*, Mountain Mahogany: leaf × 2/3.

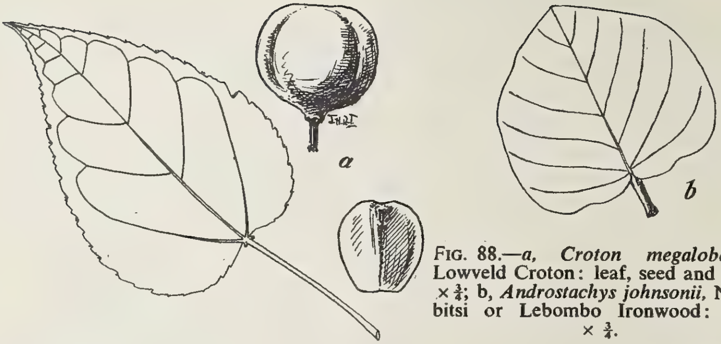


Fig. 88.—*a, Croton megalobotrys,* Lowveld Croton: leaf, seed and fruit, × ¾; b, *Androstachys johnsonii,* Nsimbitsi or Lebombo Ironwood: leaf, × ¾.

The trunk is white and smooth and the small, grey-green leaves are oval in shape and about 1 inch long. Numerous sweet-scented, mauve-purple flowers are produced in early summer, and they superficially resemble pea flowers, though the structure is different. The fruit is an unusual one, consisting of an oval, woody nut with a large wing, the size of a locust's wing, attached. The generic name is derived from the Latin *securis*, a hatchet, in allusion to the shape of the fruit.

The wood is pale in colour, soft, light and brittle and is, therefore, of no value. The branches are used as a source of fibre and there is a persistent belief that the bark is used as an ingredient in arrow poison. Watt and Brandwijk state that a decoction of the root is used by the natives for chest complaints and the fresh root is chewed for toothache, in fact it has been found possible to extract an oil from the roots containing 99 per cent. of methyl salicylate.

EUPHORBIACEAE. Euphorbia family.

A large family of 4,000 or more species, showing a wide diversity of growth form from small herbs and shrubs to large trees, and including many strange desert succulent plants. The milky latex of several species may be used in the preparation of rubber, the most famous being *Hevea brasiliensis,* the source of the common Para rubber. *Ricinus* (castor-oil) and *Croton* yield valuable oil-seeds, while tapioca and cassava are obtained from *Manihot.* Several other species provide medicinal products, while not a few are poisonous. The so-called flowers are usually small, but the bracts (leaves surrounding the flowers) may assume bright colours, as in the Poinsettia, which has been planted in several of the Rest Camps for its ornamental effect.

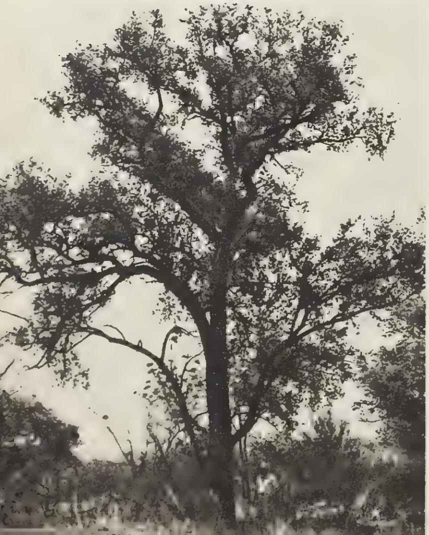


Fig. 89.—*Androstachys johnsonii,* Nsimbitsi or Lebombo Ironwood, near Punda Maria.

[*Photo by Dr. R. A. Dyer.*

The family is well represented in the Kruger National Park, the more important woody genera being dealt with in the following order: *Androstachys* (1 species), *Croton* (4 species), *Euphorbia* (4 species), *Pseudolachnostylis* (1 species), *Spirostachys* (1 species) and *Synadenium* (1 species). Certain other genera which then receive brief mention are: *Acalypha, Antidesma, Bridelia, Fluggea, Phyllanthus* and *Ricinus*.

107. Androstachys johnsonii Prain. LEBOMBO IRONWOOD; NSIMBITSI (Shangaan). Figs. 88b and 89.

The native name means "iron wood" and it may be noted that in Zululand a different tree, *Millettia caffra* (family: Leguminosae), is known by the name *Msimbite* (iron wood).

Timber used in constructing huts in the Shingwedzi and Punda Maria Rest Camps comes mainly from the Lebombo Ironwood trees growing in the neighbourhood of Punda Maria and, as the name suggests, the wood is hard, durable and resistant to termites.

This species seems to be confined to the Lebombo and north-eastern Zoutpansberg Ranges, where is grows on rock ridges and low, stony outcrops. It usually grows communally in groves or small forests, often to the exclusion of other trees, and it casts very little shade.

The trunk is straight with a dark, grey-black, rough bark. The leaves are broadly kidney-shaped, leathery, dark green and shiny on the upper surface and densely white-felted below. They turn yellow-brown in winter and are shed irregularly. It was noted that cattle browse on the leaves of trees growing on the northern side of the Zoutpansberg range. The flowers are minute and are produced in small catkin-like spikes, the male and female flowers being in different spikes. The generic name *Androstachys* alludes to this character and means "male flowers in spikes".

108. Croton megalobotrys Müll.-Arg. LOWVELD CROTON; SHUNGUSHUNGU (Shangaan). Fig. 88a.

A densely leafy, deciduous tree or shrub of the alluvial flats along the rivers in the northern part of the Park, chiefly northwards from the Olifants River. Trees may be seen in the Pafuri and Letaba Rest Camps. The species is widespread in tropical east and west Africa and extends as far south as the northern Transvaal and Portuguese East Africa.

The leaves are roughly triangular in shape, about 2½ inches long and 2 inches wide at the base, and are borne on longish, slender leafstalks. The fruits are roundish, hard capsules containing three large seeds which are

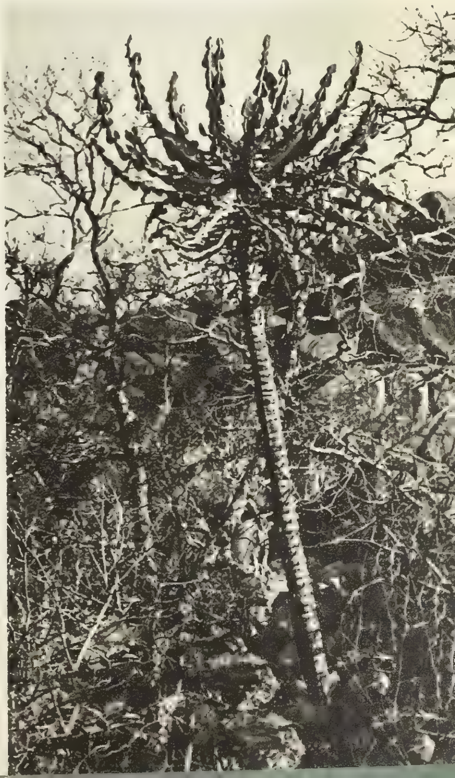


FIG. 90.—*Euphorbia cooperi*, on Shir
Mountain.

crushed by the natives and used as a powerful purgative. The bark contains a bitter principle which is possibly of medicinal value. Before the advent of quinine, the bark was ground and made into pills as a treatment for malaria. It is also said to be used as a fish-poison. The wood is light and coarse-grained and of little value.

Other species of *Croton* found in the Park are: *C. pseudopulchellus* and *C. zambesiacus* (chiefly around Punda Maria) and *C. sylvaticus*, which occurs as a small shrub in wooded places near Malelane.

Euphorbia.

The name Euphorbium was used in classical times for a plant of this genus and is said by Pliny to be in honour of King Juba's physician, Euphorbus. The genus *Euphorbia* as we understand it to-day includes a number of herbaceous plants as well as the very varied and strange succulent forms, some of which attain to the size of large trees. Some of the tree forms, for example the Naboom (*Euphorbia ingens*), impart a striking scenic effect to some of our dry, bushveld countryside.

The tree Euphorbias found in the Park are: *E. cooperi, E. ingens, E. tirucalli* and *E. confinalis*.

109. Euphorbia cooperi N.E.Br. SHIHAHA (Shangaan); UMHLOHLO (Swazi).

A tree Euphorbia growing up to 12 or 15 feet high with a candelabra-shaped crown of spreading-ascending branches, found on rocky koppies in the southern part of the Park and also around Punda Maria. It is widespread on rocky situations in the dry bushveld of the Transvaal and occurs also in Zululand, Swaziland and Southern Rhodesia.

The branches come out horizontally from the main trunk, or at a wide angle, and the older branches are shed as the trunk elongates. Thus

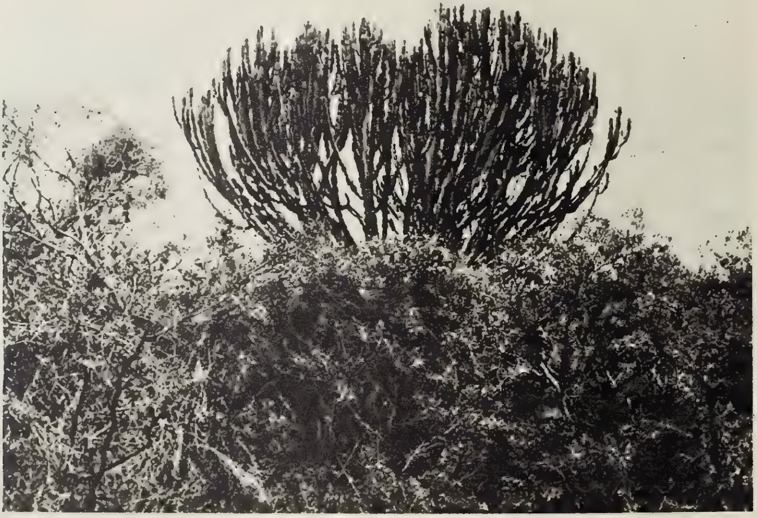


FIG. 91.—*Euphorbia ingens*, Naboom, near Pretorius Kop.

the older trees show only a small crown of branches at the top of a long, bare trunk, in distinction to *Euphorbia ingens* (the Naboom), which retains the lower branches. The branches of *Euphorbia cooperi* are deeply angled or lobed, much more so than in *E. ingens*. Strong spines are produced in pairs along the ridges of the branches in both species but, in *E. cooperi*, there is a continuous horny strip along the ridges of of the branches, whereas in *E. ingens* it is not continuous. The fruits are also different, those of *E. cooperi* being distinctly three-angled while those of *E. ingens* are practically spherical. In both species, the milky latex contained in the stem is very irritating to the skin.

110. Euphorbia ingens E.Mey. NABOOM; NKONDE (Shangaan). Fig. 91.

The Naboom forms a larger tree than the former species and some fine specimens may be seen on the sandy, granite slopes around Pretorius Kop Rest Camp, often associated with bush clumps. It is common in the dry bush country of Natal, Swaziland and the Transvaal, often dominating the landscape with its unusual shapes, and occurs also in Portuguese East Africa, the Rhodesias and possibly as far north as Kenya.

The lower branches are not shed as in *E. cooperi* and they are more erect, forming a dense, many-stemmed crown by repeated branching. The branches are usually four-angled and are less deeply ridged than in *E. cooperi* and other distinctions are pointed out in the description of that species.

The milky latex is collected by natives from incisions made in the stems and is used as a fish-poison. It is known as *ishupa* and the name is also applied to this and other species of *Euphorbia* used in the same way. The fresh latex will blister the skin, while a drop falling in the eye will cause intense agony and temporary blindness. The wood is exceptionally light and tough, but has no commercial value.

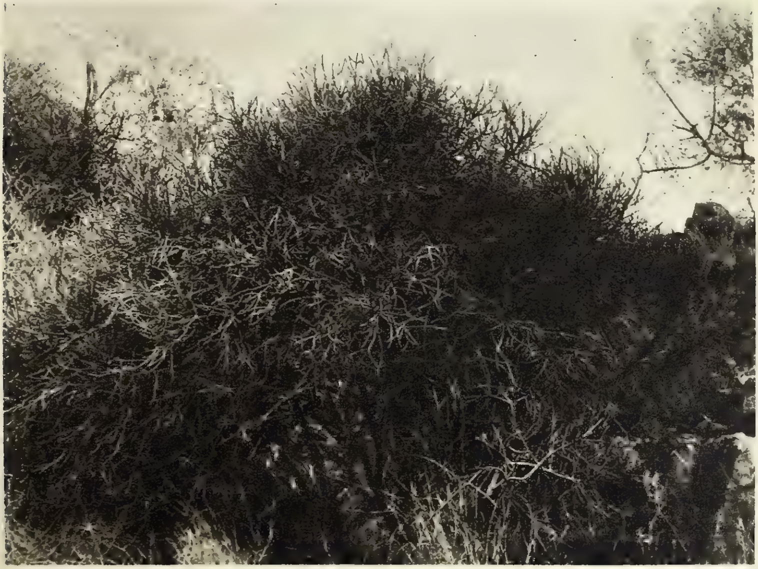


FIG. 92.—*Euphorbia tirucalli*, Rubber Euphorbia, near Skukuza.

111. Euphorbia tirucalli L. RUBBER EUPHORBIA; MAHUMBANA (Shangaan). Fig. 92.

A shrub or tree growing to 12 or 15 feet high with masses of cylindrical, pencil-like, succulent branches. In the Kruger National Park, a few shrubby specimens may be seen at the north end of the Sabi River causeway, near Skukuza, and odd plants are scattered on river banks and wooded hillsides in the southern part of the Park. It is a widespread species, its distribution extending from Uganda, through tropical Africa to Komgha in the south.

It is abundant in dry river valleys in Natal and was studied as an emergency source of rubber. Investigation showed that the milky latex must first be purified of resins and other impurities before it could be used for this purpose. The latex is poisonous to the skin and, probably for this reason, natives frequently plant hedges of *Euphorbia tirucalli* around their kraals.

112. Euphorbia confinalis R. A. Dyer.* LEBOMBO EUPHORBIA. Fig. 93.

This tree Euphorbia occurs in the Kruger National Park on the crests of the Lebombo range in the neighbourhood of the Gorge and also on the broken country northwards from Punda Maria. It has also been collected near Komatipoort and in Portuguese East Africa and may be seen on the crests of koppies about 14 miles south-west of Punda Maria on the road to Louis Trichardt.

This Euphorbia grows to 20 or 25 feet in height forming a clean main trunk and a crown of narrow, succulent four-angled branches, with paired spines along the ridges of the branches.

Other succulent Euphorbias found in the Park are *E. schinzii* Pax and *E. aeruginosa* Schweick., both low-growing, spiny, succulent shrubs with numerous 4-angled stems about 12 inches high, the last named growing in rock crevices in the quartzite formation north of Punda Maria. In addition, there is an unidentified shrubby species with many succulent, spiny stems, mostly 5-angled, up to 4 feet in height, which grows in the rocky country between Punda Maria and the Levubu River.

There are also a few succulent members of related genera in the Park, for example, *Monadenium lugardae, Pedilanthus tithymaloides* (an exotic) and *Synadenium cupulare* (for a description of this species, see page 101).

Monadenium lugardae N.E.Br. usually produces many succulent, cylindrical stems 12 to 18 inches in length, either erect or decumbent, containing a milky latex. The stems are spineless and there is a tuft of semi-fleshy leaves at the apex of each stem. A group of plants may be seen in the Crocodile Bridge Rest Camp, and the species is found on the dry, rocky slopes of the Lebombo Range.

113. Pseudolachnostylis maprouneaefolia Pax. KUDU-BERRY; NSHOJOWA (Shangaan). Fig. 94.

A deciduous, round-topped tree or shrub growing up to 25 feet high on the ridges and sandy flats near Punda Maria (there is a tree in the Rest Camp, near the restaurant) and not found elsewhere in the Park.

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* Bothalia, Vol. 6, pt. 1 (1951).

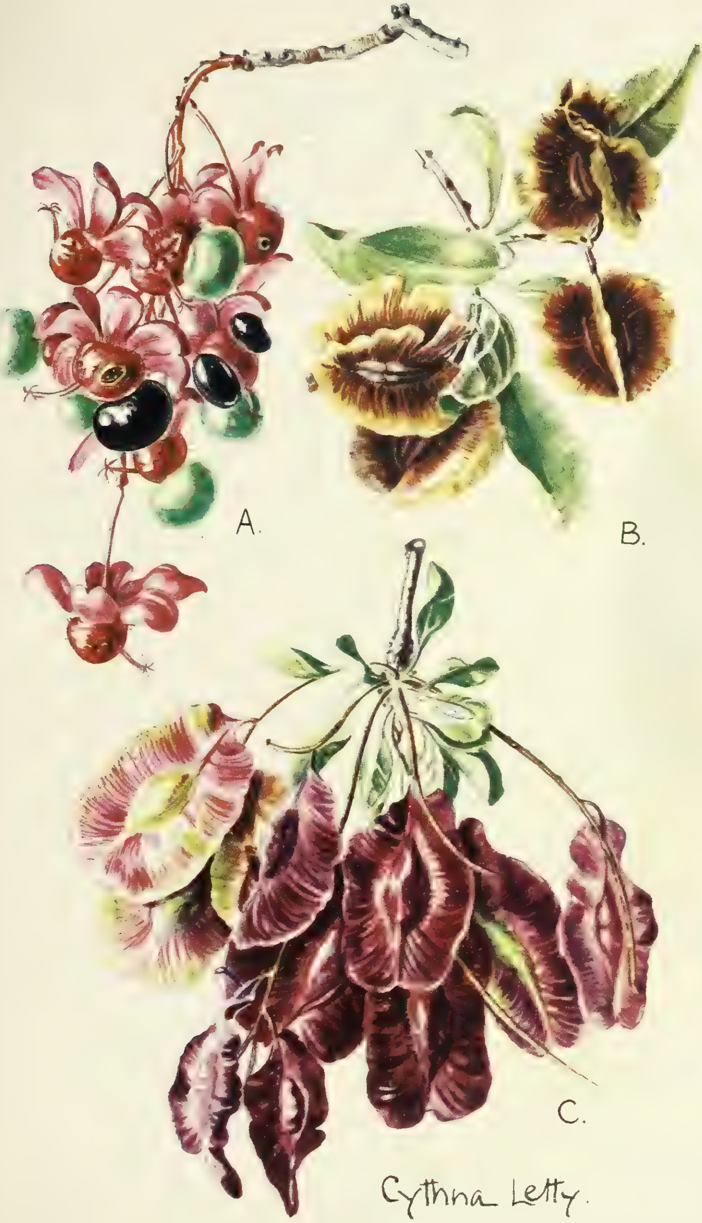


Plate IV.

Fruits of some lowveld trees: (*a*) *Ochna pulchra*, Lekkerbreek (see page 124); (*b*) *Combretum transvaalense*, Russet Bush-willow or Kierieklapper (page 133); (*c*) *Terminalia prunioides*, Lowveld Terminalia or Sterkbos (page 134).

It is, however, common on the Waterberg and Zoutpansberg ranges, where it is much reduced in stature, growing as a graceful small tree or shrub 10 to 15 feet high. It is also found in Rhodesia, Bechuanaland and Angola.

The leaves are oval to roundish, 1¼ to 1¾ inches long, smooth and grey-green in colour, developing beautiful reddish tints in autumn before they are shed. The flowers are quite inconspicuous. The fruits are round and hard, consisting of a hard, woody centre with a thin fleshy covering, pale yellow when ripe. The wood is close-grained, of a light biscuit colour with darker streaks and gives off a distinct medicinal odour when worked. Stems of timber size are rarely encountered.

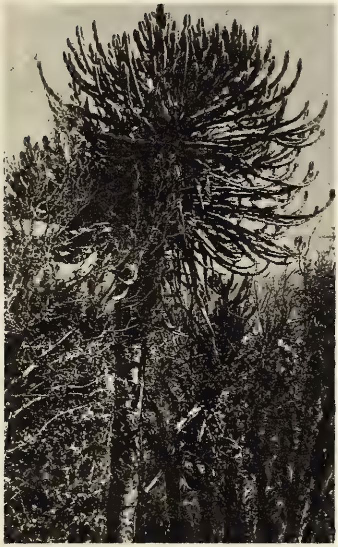


FIG. 93.—*Euphorbia confinalis*, Lebombo Euphorbia, on the Lebombo Range, near The Gorge Rest Camp.

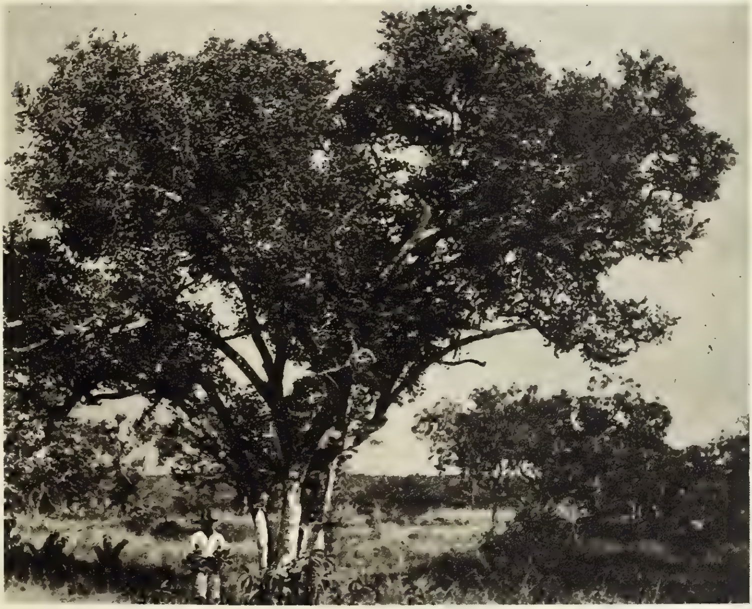


FIG. 94.—*Pseudolachnostylis maprouneaefolia*, Kudu-berry, near Punda Maria.

114. Spirostachys africanus Sond. TAMBOOTIE; NDZOPFORI (Shangaan); UMTHOMBOTSI (Swazi). Figs. 95 and 96.

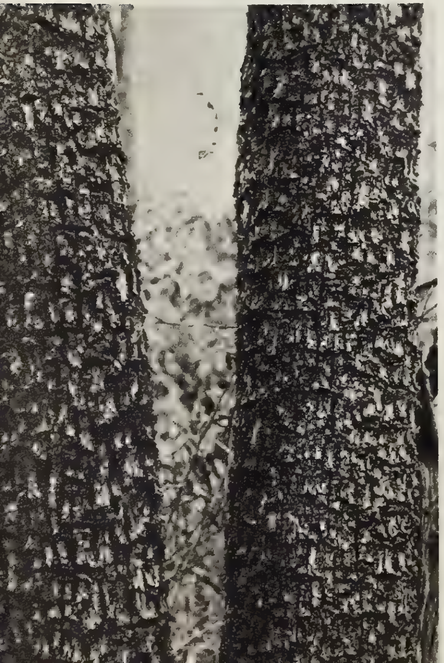
A deciduous tree of 20 to 30 feet in height, usually found growing communally on low lying, brackish flats, or on river banks. It is scattered throughout the Park, and its distribution extends from Angola and Tanganyika to the frost-free bushveld of Natal and the Transkei.

The leaves are elliptic and smooth, tapering slightly towards the apex, 1 to 1½ inches long, greyish-green, in colour, with toothed leaf margins. From mid-summer, the leaves begin changing to attractive reddish colours before being shed in the autumn. Although completely leafless for the greater part of the tourist season, the Tambootie can be recognised by its rough, black bark, which cracks into neat, rectangular sections (Fig. 95).

The flowers are produced in small, inconspicuous spikes, usually before the young leaves appear, the male and female flowers being in different spikes. The name *Spirostachys* is derived from the Greek words for *spiral flower spikes* and refers to the structure of the small flower-spikes (see Fig. 96).

The fruit is a dry, three-lobed capsule, which breaks into three small, pea-like sections, each containing one seed. The fruits ripen and fall to the ground a week or so before Christmas and are often parasitised by an insect, the larvae of which develop inside the seeds and are able to jerk themselves and their coverings an inch or two into the air. The resulting "jumping beans" are most diverting and are a never-failing source of amusement, maintaining their activity for two or three weeks, especially when they are warmed by placing them in the sun or near a heater.

FIG. 95.—*Spirostachys africanus*, Tambootie, close-up of tree trunks, showing the characteristic bark.
[*Photo by Dr. R. A. Dyer.*



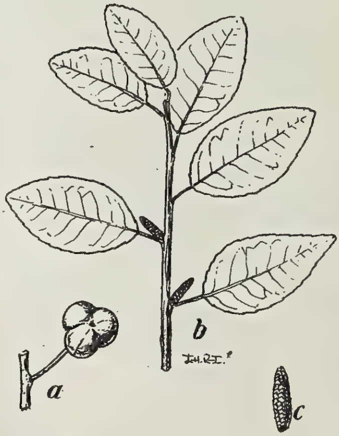


FIG. 96.—*Spirostachys africanus*, Tambootie: a, male flowering twig, × ¾; b, fruit, × ¾; c, male flower-spike, × 1.

Tambootie timber is hard, heavy, beautifully grained and durable, making attractive furniture. When freshly worked, it has a distinctly sweet scent which persists for a long time. Most of the larger Tambootie trees in South Africa have been felled for timber.

The stems contain a milky sap which is acrid and causes severe pain and irritation if it enters the eyes. Tambootie bark is a regular stock-in-trade of the native medicine-man. It is powdered in small doses as a powerful purgative but, owing to its highly toxic properties, it should be used with caution and it is suspected that deaths have occurred through overdosing.

115. Synadenium cupulare (Boiss.) L. C. Wheeler.

A succulent, spineless shrub or small tree with milky latex, related to *Euphorbia.* The stems are cylindrical with tufts of leaves towards the ends of the branches. The leaves are 2 to 3 inches long and 1 to 1½ inches broad, obovate (broader above the middle) and taper towards the short leaf-stalk. They are fleshy in texture and are splashed with bright reddish blotches on the under surfaces. It has been found as a many-stemmed slender shrub in the Malelane area while, near Satara, there is quite a large round tree of this species about 10 feet high with a main stem about 6 inches thick, said to have been planted on a native's grave. It also occurs in Natal, Swaziland and the Zoutpansberg District of the Transvaal.

The plant is reputed to be extremely poisonous. Dr. Medley Wood reports that, when collecting specimens for the Durban Botanic Gardens, he covered his face and kept the specimens at arm's length, but even after washing his hands and face, he felt the irritating effects on his eyelids, nostrils and lips for several hours afterwards. Either this report is exaggerated or the virulence varies form place to place because, when specimens were recently collected in the Kruger National Park, they were kept with us in the car for some hours without our suffering any ill effects.

The foregoing are the commonest and most interesting woody species of the family Euphorbiaceae found in the Kruger National Park but there are, in addition, quite a number of small trees and shrubs belonging to other genera that are present in the Park but are not of great importance.

The genus *Acalypha* is represented by several herbaceous species, while one species grows to a soft shrub 4 or 5 feet high, namely, *Acalypha glabrata* Thb., recorded on wooded stream banks in the southern part of the Park.

Alchornea schlechteri Pax is a similar soft shrub with large, deciduous leaves, common on the Punda Maria hillside, in well wooded places, together with *Hymenocardia capensis* (Pax) Hutch., a slender shrub with characteristic winged fruits.

116. Antidesma venosum Tul. PHALAKHWARI (Shangaan); UMHLALANYONI (Swazi). Fig. 97a.

This species is widespread in Africa, occurring from Upper Guinea and the Sudan to Natal, and is scattered throughout the Park. It grows up to 20 feet high, with large, oval leaves which are roughly veined on the under surface. The small round fruits are in slender sprays and consist of a hard seed with a fleshy, edible covering which is white in the young stage, turning red and, finally, black when ripe. The Swazi name for the tree refers to the fact that the fruits are eaten by several kinds of birds. The young inflorescences are frequently parasitised by an insect, resulting in a distorted, much-branched sterile growth.

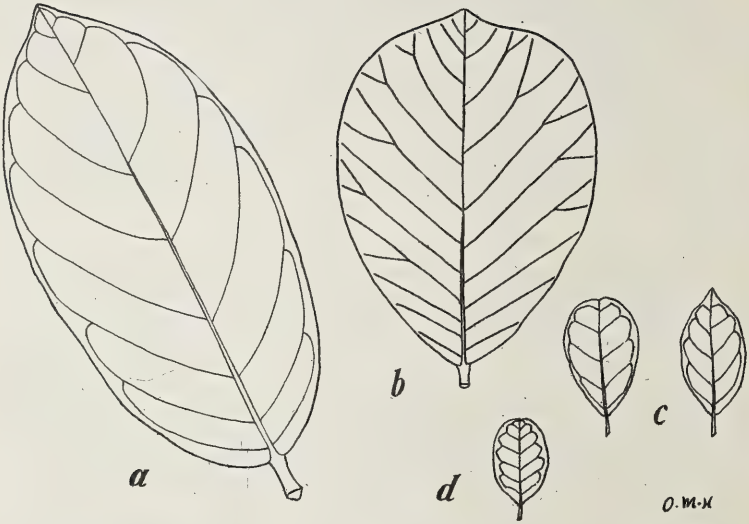


FIG. 97.—a, *Antidesma venosum;* b, *Bridelia mollis;* c, *Fluggea virosa,* showing variation in leaf shape; d, *Phyllanthus reticulatus.*

117. Bridelia mollis Hutch. SWATIMA (Shangaan). Fig. 97b.

A deciduous species which grows on rocky hillsides around Punda Maria, occurring on the wooded hillside within the Rest Camp. It is distributed from the Zambesi basin to the Transvaal, showing a preference for rocky, wooded situations, such as the Zoutpansberg, Waterberg and Magaliesberg Ranges. It forms a shrub or small tree up to 12 feet high with large, oval, roughly veined leaves, broad at the apex and covered with soft hairs. Solitary fruits are produced on short stalks in the axils of the leaves. They are globose, consisting of a hard seed surrounded by a fleshy covering, black when ripe and are less than ½ an inch in diameter. A better known species, the timber tree known as Mtserie, *Bridelia micrantha* Baill., is represented by a tree, probably planted, in the Pretorius Kop Rest Camp. It has not yet been collected in the wild state in the Park, though it is known to occur in the lowveld. A third species, *Bridelia cathartica* Bertol., grows as a much branched, leafy shrub on the densely wooded banks of the Levubu River in the extreme north of the Park.

118. Phyllanthus reticulatus Poir. THETHENYA. Fig. 97d.

This is a straggly shrub or small tree which may be seen in the grounds of the Crocodile Bridge, Letaba and Punda Maria Rest Camps. It makes a twiggy growth with small oval leaflets about ¾ of an inch long. The genus *Phyllanthus* is well represented in the Park and three other low shrubby species occur in the Punda Maria area, namely, *P. discoideus, P. kirkianus* and *P. sepialis. Fluggea virosa* Baill, called Nhlangaume by the Shangaans, is very simalar in appearance to *P. reticulatus,* making a dense twiggy growth 6 to 8 feet high with small oval leaves [Fig. 97 (*c*)] and, usually, spine-tipped branchlets. The small white fruits are eaten by natives.

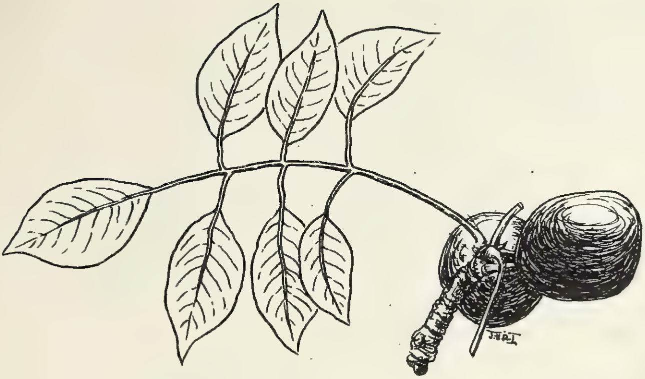


FIG. 98.—*Sclerocarya caffra*, Marula: leaf and fruits, × ½.

ANACARDIACEAE. Mango and Marula family.

Most members of this family are trees or shrubs, often with useful edible fruits, for example, the mango, cashew nut, pistachio nut and, in South Africa, the Marula (*Sclerocarya caffra*) and Kaffir-plum (*Harpephyllum caffrum*).

Although included in his list by Colonel Stevenson Hamilton, I have not yet succeeded in finding *Harpephyllum caffrum* in the Park, though further search may very likely disclose it. Genera recorded in the Park are: *Sclerocarya* (1 species), *Lannea* (2 species), *Heeria* (3 species) and *Rhus* (3 species).

119. Sclerocarya caffra Sond. MARULA; MAROELA; NKANYI (Shangaan); UMGANU (Swazi and Zulu). Figs. 98 and 99.

The name *Sclerocarya* is derived from the Greek words for *hard nut* or *kernel* in allusion to the large, woody kernel of the fruit.

The Marula is a tree of 30 feet or more in height, with a well developed trunk and a large, spreading, round-topped crown. Unfortunately, it is one of the first trees to lose its foliage and it remains bare for several months, though it can usually be recognised by its greyish, mottled bark. It is common throughout the Park and is widespread from east and west tropical Africa to Natal. Some fine specimens are to be seen in several of the Rest Camps, for example, Pretorius Kop, Skukuza, Malelane, Crocodile Bridge, Satara and Punda Maria.

The leaves are pinnate with three or four pairs of well spaced leaflets and a terminal leaflet. The leaflets are oval, smooth, tapering to an abrupt point, and are about 1½ inches long and 1 inch wide. Flowers are inconspicuous and are produced in small sprays just before the appearance of the young leaves, some trees being predominantly male and others mainly fruit-bearing. The edible fruits are somewhat oblong in shape about the size of a small plum, consisting of a firm skin, pale yellow when ripe, enclosing a large, hard kernel, to which adheres a soft, whitish, fibrous flesh, with a sweet-acid refreshing flavour.

The fruits are much sought after by baboons and monkeys, while elephants eat them in large quantities. Natives collect the fruits to make an alcoholic beverage and it is noticeable that Marula trees are among the few species left standing when natives clear land for cultivation.

Usually two seeds are contained inside the hard kernel and they contain a high percentage of oil and protein, but there is too much " stone " to make it worth while extracting the seeds. Native women in Zululand crush the kernels and boil the mass with water until an oily residue is obtained, which they use to rub on their skin skirts (" sidwaba ") to preserve them and keep them soft.

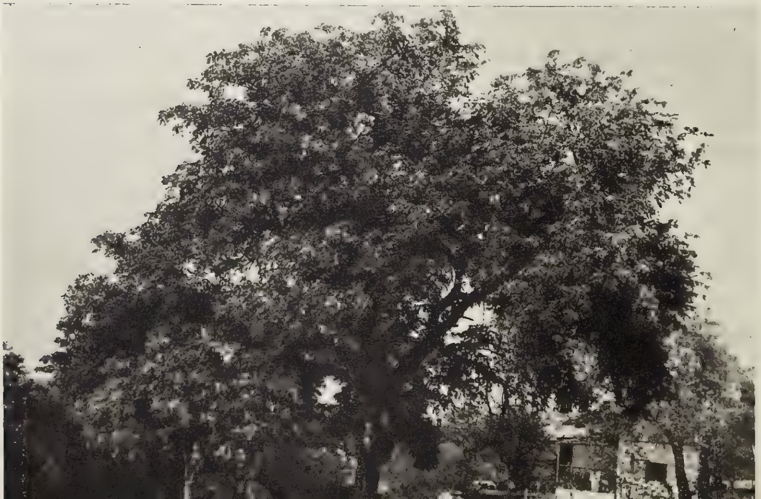
The bark is greyish and fairly smooth, flaking when old, giving the trunk a mottled appearance. The sap-wood is greyish and the heartwood pinkish in colour. The wood is light and fairly tough and may be used for fruit boxes, while the natives use it mainly for making stamp-blocks, troughs, spoons etc. According to Watt and Brandwijk, the bark contains a bitter principle and a brandy tincture of the bark was, at one time, used as a prophylactic against malaria. The natives also make use of its medicinal properties, a decoction of the bark being used in the treatment of dysentry and diarrhoea.

120. Lannea discolor Engl. BAKHOUT, DIKBAS; SIGANGANYANE (Swazi). Fig. 100a.

The Swazi name may be translated as the "Small Marula ". It is a deciduous tree, smaller than the Marula, and is bare of leaves for several months, so it is not at all conspicuous during the tourist season, except around Pretorius Kop during the summer months. It is a common constituent of the large-leaved deciduous bush around Pretorius Kop and is also found on sandy flats near Punda Maria. It is also common on the rocky slopes of the Magaliesberg, Waterberg and Zoutpansberg Ranges and extends into Southern Rhodesia, Bechuanaland and Nyasaland.

The leaves are pinnate, being made up of 3 or 4 pairs of well-spaced leaflets and a terminal leaflet. The individual leaflets are oval, about 1½ inches long and ¾ of an inch wide, dark green on the upper surface and distinctly white-felted on the under surface. Small creamy-coloured flowers are produced in slender sprays at the ends of the rather stumpy branchlets, before the young leaves appear. The fruits have much the same structure as those of the Marula, but are much smaller, being less than ½ an inch long and flattened. They are composed of a central " stone " surrounded by a thin fleshy covering, which is much relished by monkeys and birds.

FIG. 99.—*Sclerocarya caffra,* Marula, in Punda Maria Rest Camp. [*Photo by Dr. R. A. Dyer.*



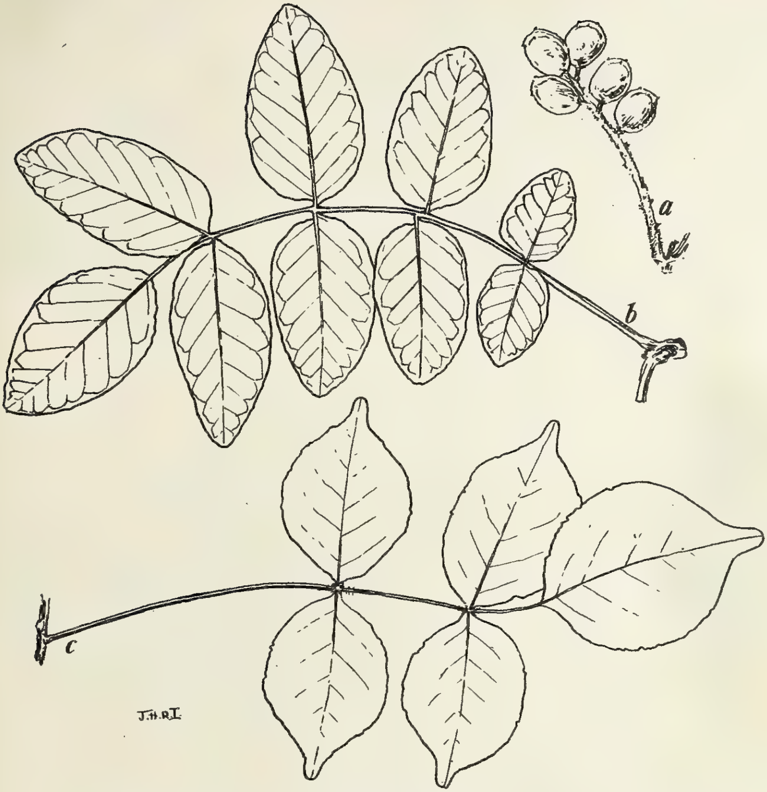


FIG. 100.—a and b, *Lannea discolor,* Bakhout: fruits and leaf, × ¾; *Lannea kirkii,* False or Baster Marula, × ¾.

Like the Marula, the wood of the Bakhout is soft and light and of little value beyond being used by natives for making stamp-blocks, dishes, etc. The bark of the young twigs is fibrous and is stripped by the natives for use as twine.

121. Lannea kirkii Burtt Davy. BASTER-MAROELA; NDIVATA, SHIMOMBONKANYI (Shangaan); UMGANUNKOMO (Swazi). Fig. 100b.

The first Shangaan name means the "Tree of Forgetfulness" probably in allusion to the tasty fruits. It is a common tree of the Park, especially south of the Olifants River and is very numerous on the road southwards from Skukuza to Malelane. A good specimen may be seen in the Punda Maria Rest Camp. It is essentially a tree of the lowveld, preferring the dry, bush country at altitudes of less than 2,000 feet in the eastern Transvaal and, north of the Zoutpansberg, in the Messina-Dongola area, occurring also in Portuguese East Africa and the Zambesi valley.

It is a graceful, deciduous tree, up to 30 feet high, with a clean, straight trunk and a round crown of pale green foliage, which turns yellow in autumn, when it closely resembles the autumn foliage of an apricot tree.

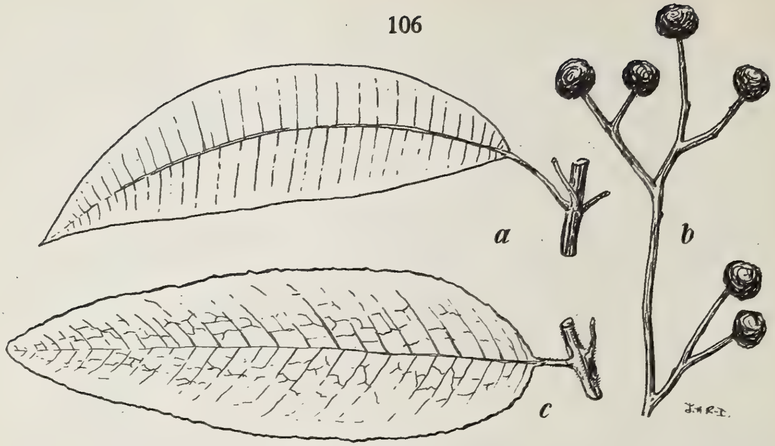


FIG. 101.—a and b, *Heeria insignis,* Resin-bush: leaf and fruits; × ¾; c, *Heeria reticulata,* Lowveld Resin-tree, × ¾.

During the winter months, when it is completely bare, it is not easily distinguishable from the Marula, because of its grey-mottled, rather smooth bark and similar branching habit.

The pinnate leaves have long, slender leaf-stalks with one or two pairs of leaflets and a terminal leaflet. The leaflets are large, roundish to ovate, 1½ to 2 inches long and 1 to 1½ inches broad and narrowing abruptly at the tip. The terminal leaflet is usually larger than the laterals. Small flowers are produced in numerous sprays at the ends of the branchlets in October or November, together with the young leaves. The fruits are about the same size as those of *Lannea discolor*, about ½ an inch long and rather flattened, consisting of a hard kernel surrounded by a thin fleshy covering turning black when ripe. They are eaten by monkeys and a variety of birds.

122. Heeria insignis (Del.) O.Ktze. RESIN-BUSH; HARPUIS; SHINUNGUMAFI (Shangaan). Figs. 101a and b.

A much branched shrub up to 6 or 8 feet high, common in the Park, southwards from Satara, especially associated with open Knobthorn parkland on turfy flats. It is a widespread species, extending throughout tropical Africa to Abyssinia and Senegal.

The leaves are narrowly oblong, 3 to 5 inches long and ½ to ¾ of an inch wide, with short leaf-stalks, and they are usually arranged in threes on the branchlets. They are dark green on the upper surface and silvery below. A distinct mid-rib runs the length of the leaf with numerous secondary veins coming off at right angles from the mid-rib to the edge of the leaf.

Flowers are small and whitish and are produced in sprays at the ends of the branches. When ripe, the fruits are black, ovoid in shape, less than ½ an inch long, consisting of a hard kernel surrounded by a tough, fleshy layer. The sap is very resinous, a characteristic of most species of Heeria.

123. Heeria reticulata Engl. LOWVELD RESIN-TREE; SHINUNGU (Shangaan); SIFICI (Swazi). Fig. 101c.

This species grows to tree stature with a spreading crown up to 12 feet high, and inhabits the large-leaved deciduous bush on greyish, sandy soil around Pretorius Kop. The leaves are larger than those of the previous species and are not silvery below, while the secondary veins are

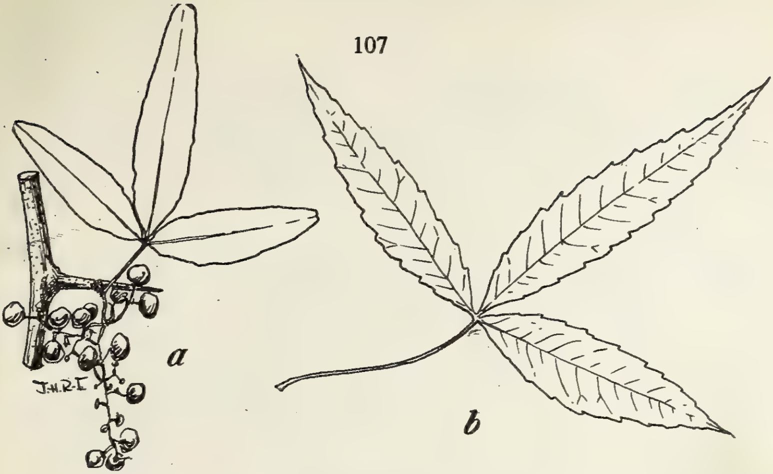


Fig. 102.—a, *Rhus spinescens,* Spiny Karee: fruiting twig; b, *Rhus gueinzii,* False or Baster Karee.

raised into a distinct network on the underside of the leaf. Its distribution is confined to the bushveld of northern Transvaal and the eastern Transvaal lowveld. A third species grows to a height of 10 or 12 feet in the Punda Maria area. It closely resembles the common Resin-tree of the Magaliesberg and the Waterberg, *Heeria paniculosa,* but has larger leaves and may be a distinct species.

Rhus.

Several species of the genus *Rhus* occur in the Kruger National Park, but they are somewhat rare and are not such a conspicuous feature as they are in parts of the northern Cape Province and Transvaal bushveld. All South African species of *Rhus* have leaves divided into three leaflets at the end of a slender leaf-stalk (petiole), the leaflets varying considerably in size and shape in the different species. The true Karee (*Rhus lancea* L. f.), with long, narrow leaflets, has been planted for a short distance along the boundary fence of the Pretorius Kop Rest Camp, but does not occur naturally in the Park.

124. Rhus pyroides Burch.

A much branched, leafy shrub or small tree, found along stream banks, especially in the southern part of the Park. The leaves are trifoliolate, with softly hairy, oval leaflets, with the margins not conspicuously toothed. It is wide-spread in South Africa, occurring in all four provinces and in Bechuanaland.

125. Rhus gueinzii Sond. False or Mountain Karee. Fig. 102b.

This species is common on the Magaliesberg and Waterberg and is a graceful tree with light green foliage. It is, however, rare in the Park, being found on rocky koppies in the south and around Punda Maria, and rarely develops beyond shrub size. The trifoliolate leaves are completely smooth, the leaflets being lance-shaped with distinctly toothed leaf margins. The young twigs and leaf-stalks are often reddish in colour.

126. Rhus spinescens Diels. Spiny Karee. Fig. 102a.

A twiggy shrub up to 6 feet high with spine-tipped branchlets and glossy green, trifoliolate leaves. It is scattered throughout the Park, especially on brackish flats where it is associated with thorn scrub.

CELASTRACEAE. Pendoring family.

Four genera belonging to this family have been found in the Kruger National Park: *Gymnosporia, Cassine, Pseudocassine* and *Putterlickia.*

127. Gymnosporia buxifolia (L.) Szysz. PENDORING; SHIHLANGWA (Shangaan).

A much-branched spiny shrub, scattered throughout the Park and common in bush-clad country throughout South Africa. It grows to about 12 feet high and retains its leaves throughout the year. The leaves are small, grey-green, broadening towards the tip, rarely more than 2 inches long and thickish in texture. The branches are usually closely packed with leaves and bear conspicuous long, straight, greyish spines which are modified branchlets and frequently bear a leaf or two towards the apex. In spring the branches become covered with dense clusters of small whitish flowers, which have a distinctly unpleasant smell. The fruit is a small, dry capsule on a short, slender stalk, breaking open into several sections to discharge the seeds.

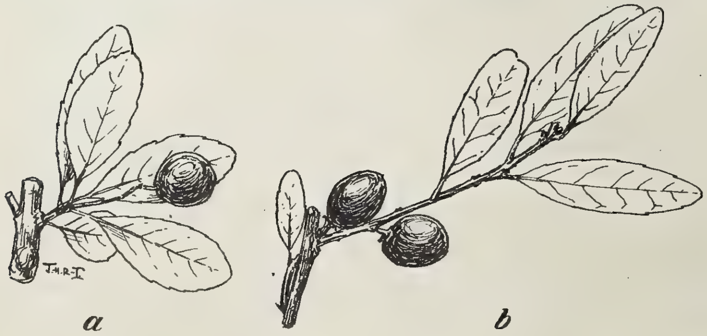
128. Gymnosporia senegalensis (Lam.) Loes. SENEGAL PENDORING; SHIHLANGWA (Shangaan).

This is another spiny, much-branched shrub, usually about 4 to 6 feet high, often forming thickets on river banks and occurring throughout the Park. It is widespread from tropical east and west Africa to Natal. The leaves are smooth and grey-green as in the previous species, broader above the middle and distinctly larger than those of *G. buxifolia.* Some plants of this species may be seen in the Malelane Rest Camp.

129. Cassine schlechteri (Loes.) Dav. LOWVELD CASSINE; NQAYI (Shangaan). Fig. 103a.

A practically evergreen shrub or small tree up to 12 feet high which grows usually on brackish, sand soil in the southern part of the Park. The leaves are smooth and leathery, dark green above and pale below, narrowly elliptical in shape, about $1\frac{1}{2}$ inches long and $\frac{1}{2}$ to $\frac{3}{4}$ of an inch wide. On mature trees, the leaf margins are very slightly toothed but on young saplings, the leaves are larger and the margins are so distinctly toothed that they appear to belong to a different species. The fruits are globose to egg-shaped, about $\frac{1}{2}$ an inch long, with a large hard centre and a thin fleshy covering, bright red when ripe.

FIG. 103.—a, *Cassine schlechteri,* Lowveld Cassine: fruiting twig; b, *Pseudocassine transvaalensis,* Lepelhout: fruiting twig.



130. Pseudocassine transvaalensis (Burtt Davy) Bredell. LEPELHOUT, OUPITJIE; SHIMAPANA (Shangaan). Figs. 103b and 104.

A deciduous tree, growing up to 30 feet high, with a round crown of grey-green foliage and a straight, clean, grey trunk. It is not common in the Park, but a large specimen may be seen about 12 miles from Skukuza on the road to Tshokwane.

The small, narrow leaves are about 1 to 1¼ inches long and about ¾ of an inch broad, greyish green in colour and completely smooth, with a leathery texture. The margins of the leaves are sometimes slightly toothed. The flowers are small and inconspicuous and are produced in clusters along the branches. They are 3-parted (3 sepals, 3 petals and 3 stamens), which immediately distinguishes *Pseudocassine* from other members of the family Celastraceae. The fruits are elliptical and hard, about ¾ of an inch in length. The wood is whitish and brittle and is used by the natives for making troughs, spoons and headrests.

HIPPOCRATEACEAE.

A small family of about 190 species of trees, shrubs and vigorous, woody climbers, distributed in the tropics and sub-tropics of Africa, Asia and America. Two genera are found in South Africa and one of these, *Hippocratea,* has been found in the Kruger National Park.

131. Hippocratea longipetiolata Oliv.

A woody climber, occurring chiefly along the Zoutpansberg Range and found recently in the Park near Skukuza. The leaves are smooth and lance-shaped, about 1¼ to 2 inches long and up to ¾ of an inch broad, tapering to the apex, with the margins faintly crenate. The flowers are small and greenish and are produced in slender sprays towards the ends of the branches. The fruit is a most peculiar one consisting of three flattened capsules diverging at the end of the stem. The capsules are oval or oblong in shape, about 1½ inches long, and they split longitudinally into halves, exposing a number of winged seeds, attached to the stem by the tip of the wing.

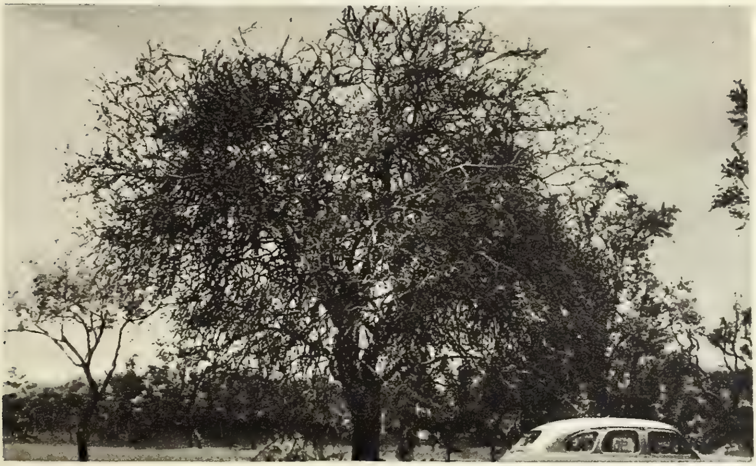


FIG. 104.—*Pseudocassine transvaalensis,* Lepelhout, between Skukuza and Tshokwane.

132. Hippocratea nitida Oberm.

This is also a woody climber with a wider distribution than the foregoing, occurring from tropical Africa to Portuguese East Africa and the Transvaal lowveld. It has been collected in the Park on rocky hillsides in the Punda Maria area. The leaves are larger than those of the preceding species and are oval or roundish, up to 2½ inches long, smooth and grey-green (glaucous) with a rounded or indented (emarginate) apex. The fruits are flat capsules like those described under the previous species, but are broader and conspicuously striated with longitudinal ridges.

SAPINDACEAE. Litchi family.

A large family of shrubs, climbers and trees, mostly tropical or sub-tropical in distribution. Some species have edible fruits, such as the Litchi but, on the whole, the family is not of great economic value.

Woody members found in the Kruger National Park are: *Pappea capensis* E. & Z. var. *radlkoferi* Schinz, *Allophylus decipiens* (Presl) Radlk. and *Hippobromus pauciflorus* (L.) Radlk. All three are found mainly in the southern part of the Park and are not very common. Only the first named receives further mention.

133. Pappea capensis E. & Z. var. **radlkoferi** Schinz. OLIEPIT, NOUPITJIE, WILDEPRUIM, BERGPRUIM, DOPPRUIM; GULASWIMBI (Shangaan).

The generic name honours Dr. Pappe who was born in Hamburg in 1803 and died at Capetown in 1862 and who held the post of Colonial Botanist for several years.

Pappea capensis is a common constituent of the scrub bush country of the eastern Cape Province, where it is extensively browsed by cattle. In the Transvaal, it grows into a larger tree and is regarded as a distinct variety of the Cape form, *P.capensis* var. *radlkoferi*. This larger variety is widespread in east and west tropical Africa and should be regarded as the original form from which the stunted Cape form has evolved in response to the more severe climate as the species migrated further to the south. In the Kruger National Park, the species grows as a shrub or small tree up to 12 feet high and is scattered in the southern part of the Park, usually associated with thorn scrub on brackish, sandy flats or " hard-pans ".

The leaves are greyish green, oblong in shape, with a rather rough texture, on the mature trees about 1 to 1½ inches long and about ½ to ¾ of an inch broad. On young saplings the leaves are hardly recognisable as the same species, growing 2 inches or more in length with distinctly toothed margins. Flowers are small and inconspicuous. The fruits are roundish, about ½ an inch in diameter, consisting of a tough skin enclosing a hard kernel covered with an edible, fleshy covering, which is red in colour when ripe and has a pleasant taste.

The wood is light to medium brown in colour, hard and tough with a very much twisted grain, and it is not often that one finds trees large enough for timber purposes.

RHAMNACEAE. Buffalo-thorn family.

A widespread family made up chiefly of shrubs, climbers and trees, some of which are useful as timber. Several species have fruits that are edible, for instance, the fruit of *Ziziphus lotus*, a native of the Mediterranean, is thought to be the " lotus " of ancient times, while the American

Buckthorn (*Rhamnus* sp.) also has an edible fruit. On the other hand, some *Rhamnus* fruits have a purgative action, the " Cascara Sagrada " of commerce, for example, being derived from the American species, *Rhamnus purshiana,* while the fruits of other species are used in the production of green and yellow dye-stuffs.

The genera with which we are concerned in the Kruger National Park are: *Berchemia, Rhamnus* and *Ziziphus.*

134. Berchemia discolor Hemsl. BIRD PLUM; NYIYI, NYIRI (Shangaan). Figs. 105 and 106a, b.

The name of the genus is in honour of M. Berchem, a French botanist.

This species is sometimes known as the Wild Almond (Wilde Amandel). It is a medium to large, deciduous tree, up to 40 feet high, which is rather rare in the Park. A specimen may be seen in the Skukuza Rest Camp and another about 5½ miles from Skukuza on the Lower Sabie road, while some large trees occur along the Levubu River in the extreme north of the Park. It is also recorded from the northern Transvaal, Portuguese East Africa, Bechuanaland, Angola, Tanganyika and Abyssinia.

The leaves are broadly oval in shape, about 2½ inches long, dark green above and paler beneath, smooth, with almost a waxy sheen. They are thin textured with a distinct " herringbone " pattern of veins on the under surface. Flowers are inconspicuous and appear at about the same time as the young leaves in October or November. The fruits are small, oblong in shape, tapering to the tip, about ½ to ¾ of an inch long, consisting of a 2-seeded kernel with a fleshy covering. The flesh is yellowish when ripe and has a sweetish flavour. The fruits are regarded in high favour by the natives and are appreciated by monkeys and several species of birds.

The wood is yellow-brown and hard, with an attractive, close grain and appears as if it would be excellent for furinture. In general texture it resembles that of the closely related Red Ivory (*Rhamnus zeyheri*), but lacks the bright pink colour shown by the wood of that species.

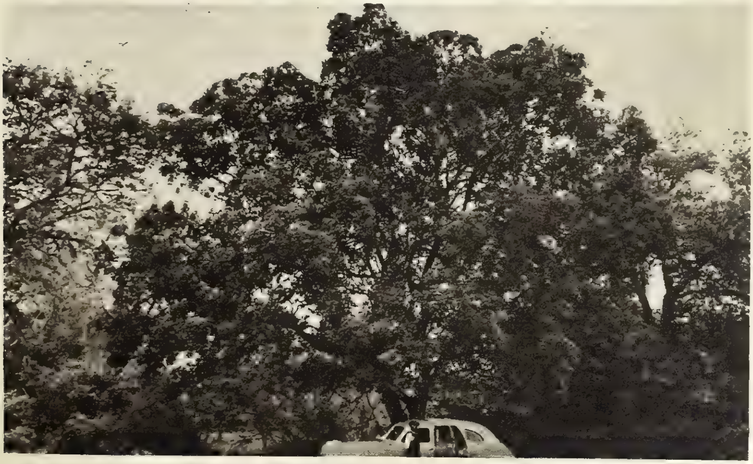


FIG. 105.—*Berchemia discolor,* Bird Plum, on Lower Sabie Road, near Skukuza.

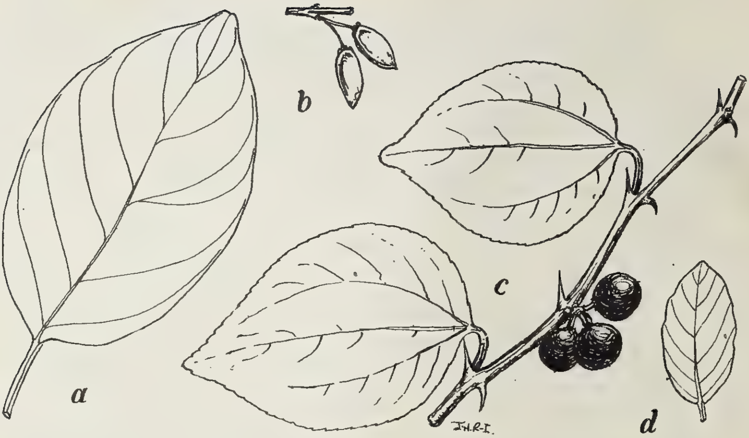


FIG. 106.—a and b, *Berchemia discolor,* Bird Plum: leaf and fruits; c, *Ziziphus mucronata,* Buffalo-thorn or Blinkblaar-wag-'n-bietjie; d, *Rhamnus zeyheri,* Red Ivory, × $\frac{1}{4}$.

135. Rhamnus zeyheri Sond. Red Ivory; siNeyi (Swazi). Fig. 106d.

The name *Rhamnus* is derived from an ancient Greek epithet for a plant of this family. The specific name commemorates Karl Ludwig Zeyher who collected South African plants on a large scale for sale in Europe and who joined James Burke in his expedition to the Magaliesberg about 1840.

The Red Ivory is a deciduous tree or shrub, growing up to about 15 feet high, scattered in wooded kloofs in the southern part of the Park, but is nowhere at all common. Its distribution extends to the bushveld areas of Natal, Transvaal, Bechuanaland and Portuguese East Africa.

The oval leaves are smooth and are similar in shape to those of *Berchemia discolor,* but they are much smaller, being only 1 to $1\frac{1}{2}$ inches long. They are greyish green in colour and the veins on the underside of the leaves, as well as the leaf-stalks and young twigs, often have a reddish-purple pigmentation. The small oval fruits, about $\frac{1}{2}$ an inch long, have a fleshy, edible covering and closely resemble those of *Berchemia discolor,* in fact, the natives do not appear to distinguish between the two species, calling both of them " Nyiyi ".

The wood is close-grained, hard and strong and the heartwood has a startling pinkish colour when freshly cut, which persists for a long time, but eventually fades to a dull red colour. It is outstanding for ornaments, small boxes etc., but the colour is too bright for furniture. Burtt Davy states that in Natal the native chiefs only were allowed to carry knobkerries made of Red Ivory.

136. Ziziphus mucronata Willd. Buffalo-thorn; Blinkblaar-wag-'n-bietjie; Mphasamhala (Shangaan); umLahlabantu (Swazi). Fig. 196c.

The spelling *Zizyphus* is now regarded as incorrect.

The generic appellation is derived from *zizouf,* the Arabian name for *Ziziphus lotus.* The Shangaan word for this species means " catches the impala ", while the Swazi name indicates that it is used in burial rites, the thorny branches probably being placed over fresh graves to deter wild animals.

The Buffalo-thorn is a deciduous, small to medium-sized tree with an intricately branched crown of thorny branches. It is scattered throughout the Park and trees may be seen in the Skukuza, Crocodile Bridge and Malelane Rest Camps. Usually it is associated with thorn trees and the Tambootie on brackish flats and stream banks and is a widespread species throughout tropical Africa, extending to Natal and the eastern Cape Province.

The leaves are glossy green, broad-based and tapering to a point, with finely toothed leaf margins. The veining of the leaf is characteristic, showing three main veins diverging from the base of the leaf. The twigs are usually armed with spines of two kinds, one straight and one recurved, shiny red-brown in colour and extremely sharp.

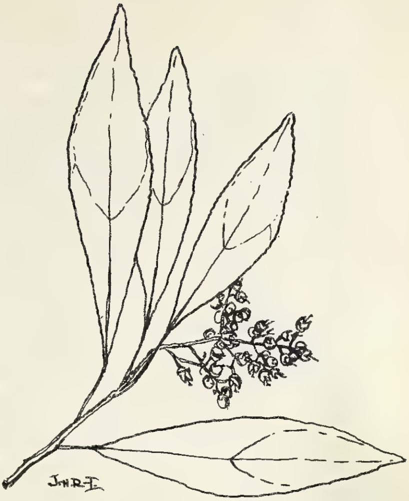


FIG. 107.—*Heteropyxis natalensis*, Lavender-tree: fruiting twig.

Flowers are small and cream-coloured and are produced in early summer in clusters close to the stems. The fruits are round, about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter, consisting of a hard, central stone surrounded by a mealy covering, the whole enclosed in a smooth, yellow-brown to reddish-brown, tough skin. Although said to be edible, the fruits are not attractive to the palate. The leaves are browsed by game and by domestic livestock and provide a useful source of fodder in times of drought.

The wood is light in colour, hard and tough and is used for many rustic purposes, though it is inclined to have a twisted grain. The Buffalo-thorn is used extensively by the natives for medicinal purposes. A decoction of the bark is used for chest complaints, poultices of leaves for boils and carbuncles and an infusion of the root for dysentry.

HETEROPYXIDACEAE. Heteropyxis family.

137. Heteropyxis natalensis Harv. LAVENDER-TREE; LAVENTEL-BOOM; THATHASANE (Shangaan); UMHLOSHENI (Swazi). Fig. 107.

This solitary species has been classified as a separate family with no very close relatives, though the scented leaves are reminiscent of the Citrus family (Rutaceae). It is a shrub or small tree up to 15 feet high, occurring on the Numbe drive near Pretorius Kop and in the neighbourhood of Punda Maria. It is also found in rocky situations in the Natal and Transvaal bushveld and is recorded from Nyasaland.

It has a twisted, greyish-white, smooth trunk and the leaves are long and narrow, 3 to 4 inches long and $\frac{1}{2}$ to $\frac{3}{4}$ of an inch wide. The twigs and leaves are aromatic, giving off a camphor-like odour when crushed. The small flowers are produced in clusters at the ends of the branches in early summer and are followed by the small, spherical, capsular fruits. The wood is of a light purplish-brown colour and is tough but difficult to season.

VITACEAE. Grape-vine family.

A family of about 480 species, mostly climbing shrubs with woody or succulent stems, the best-known member being the cultivated grape vine. Two genera, *Rhoicissus* and *Cissus*, are widespread in South Africa and both are represented in the Kruger National Park. The *Cissus* species in the Park are climbers with soft, succulent stems, one of the commonest being *C. quadrangularis*, a leafless climber with green, 4-angled, succulent stems. The *Rhoicissus* species have woody stems and three of them are described briefly below.

138. Rhoicissus capensis (Burm.f.) Planch. WILD GRAPE, MONKEY ROPE; WILDE-DRUIF.

A vigorous woody climber which is distributed from tropical East Africa to the Cape Province. It inhabits forests and bush in the eastern and northern Transvaal and has been collected in a wooded kloof near Punda Maria.

The leaves are simple and broadly kidney-shaped with a wavy or lobed margin, while the leaf-stalks and young twigs have a brown, velvety covering. The fruits are produced in lax bunches and range in colour from yellow-green, through crimson to black when ripe. They are about $\frac{3}{4}$ of an inch in diameter and consist of a smooth and shiny skin enclosing an edible, acid-tasting pulp, which can be used to make a delicious jelly. Embedded in the centre of the fruit are three smooth seeds.

139. Rhoicissus cuneifolius (E. & Z.) Planch. WILD GRAPE.

A much-branched shrub or climber, rarely exceeding 10 feet in height, with slender, woody stems. It is widespread in South Africa and is scattered on dry, rocky situations throughout the Park.

The leaves are 3-foliolate, the leaflets being wedge-shaped at the base and deeply toothed at the apex. The under-surfaces of the leaves and the young twigs have a whitish, downy covering. The fruits are smaller than in the preceding species, being less than $\frac{1}{2}$ an inch in diameter, with a relatively thin fleshy covering.

140. Rhoicissus schlechteri Gilg & Brandt. PHESA (Shangaan).

A straggly shrub which inhabits rocky, wooded hillsides of the Waterberg and Zoutpansberg ranges and which grows in the Punda Maria area. The leaves are trifoliolate and the leaflets are oblong, smooth and greyish (glaucous), while the leaf-margins are not toothed.

TILIACEAE. Jute family.

A family of trees, shrubs and herbs, including some valuable fibre plants, for example, the jute (*Corchorus* sp.). The best known South African genus of this family is *Grewia*, which is well represented in the Kruger National Park by at least 10 species, and which provides a useful source of fodder for livestock in the drier, bushveld regions. The genus *Corchorus* is also represented in the Park, but only by a few semi-herbaceous species.

Grewia.

Named after Nehemiah Grew, a famous English plant physiologist of the late seventeenth century.

There are a number of species of *Grewia* in South Africa, some of which are known under the popular names of *Rosyntjiebos* (Raisin-bush) and *Kruisbessie* (Cross-berry). They are mostly shrubs or semi-climbers, inhabiting dry, open bush country or wooded kloofs and forest margins. The stems are strong and supple, four-angled in some species, and the more slender shoots are used in native basket-making. The stronger pieces were used by bushmen for their bows and the stems of some species make good walking sticks. The bark may be peeled in long strips which provide primitive races with a substitute for twine.

The starry flowers have five sepals, coloured yellow, white or pink in different species, and five smaller petals, with numerous stamens in the centre of the flower. The ovary is usually 2 celled and one or two seeds may develop in each cell, resulting in a 1, 2 or 4-lobed fruit, the latter providing the "kruisbessie". The fruits consist of a small hard kernel with a thin, fleshy covering, which has a sweetish taste when fully ripe.

Difficulty is experienced in distinguishing between some of the species. In the Kruger National Park, 10 species have been recorded with certainty, while several plants remain to be classified. Most of them inhabit well-wooded situations, for instance, the forest fringing the Levubu River in the neighbourhood of the Pafuri Rest Camp contains at least five species. The following species are briefly described: *G. caffra, G. flavescens, G. kwebensis, G. messinica, G. monticola, G. sulcata* and *G. villosa.*

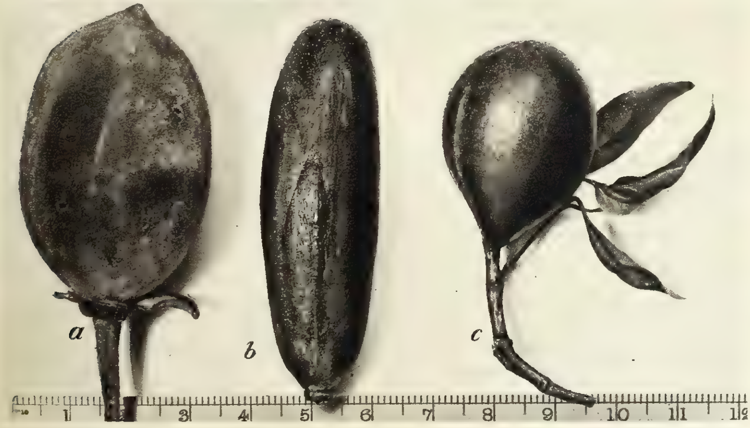
The native names *Nsihana* or *Nsihani* (Shangaan) or the Swazi equivalent *umSipane*, are applied to most species of *Grewia*, with occasional local names for certain species.

141. Grewia caffra Meisn.

A scrambling shrub inhabiting wooded places in Natal, Transvaal and Portuguese East Africa and recorded from the extreme north of the Park, near Pafuri. The older stems become distinctly 4-angled and reach a thickness of 3 or 4 inches. The leaves are oblong, 1 to 2½ inches long and ½ to 1 inch wide, tapering to a point and slightly asymmetrical at the base. They are thin textured, shiny and usually smooth on the upper surface, with scattered stellate hairs on the under surface. The leaf margins are very slightly toothed. Creamy yellow or pink flowers are producd on short, branched inflorescences in the axils of the leaves.

FIG. 108.—Lowveld fruits: a, *Adansonia digitata*, Baobab; b, *Entandrophragma caudatum*, Mountain Mahogany; c, *Rothmannia fischeri*, Rhodesian Gardenia (see also Fig. 163).

[*Photo by H. King.*



142. Grewia flavescens Juss. KRUISBESSIE. Fig. 109e.

This is also a scrambling shrub and like the preceding species, the older stems become distinctly 4-angled. It has a wide distribution from Abyssinia and Upper Guinea through tropical Africa to the Transvaal bushveld and is scattered throughout the Park. The leaves show a good deal of variation in size and texture. They are oblong, 2 to 3 inches long and 1 to 1¾ inches wide, often broader above the middle with fine, regular teeth along the margins. The leaf tapers to a point and the base of the leaf is not markedly asymmetrical as in certain other species. The upper and lower leaf surfaces are dark green and have scattered stellate hairs, making them rough to the touch. Flowers are yellow and the fruits are one to 4 seeded.

143. Grewia kwebensis N.E. Br. Figs. 109c and d.

A leafy, deciduous shrub, 4 to 5 feet high, branching freely from the base to form a bush of numerous, slender stems. It occurs in Bechuanaland and the northern and eastern Transvaal lowveld. It is most conspicuous in the Knobthorn and Marula parkland forming a distinct vegetal "layer" between the tree canopies and the ground layer of grass and small shrub. The leaves are elliptical to oblong, 1¼ to 1¾ inches long tapering to a blunt point, with a slightly lop-sided base. The upper surface of the leaf is dark green, smooth and shiny, while the under surface is covered with a dense, whitish felt. Small yellow flowers are produced on short, branched inflorescences in the leaf axils. Frequently only one seed developes per fruit, producing a small, pea-like fruit on a short stalk, but 2-seeded fruits are also found. Like many species of Rosyntjiiebos, the leaves and twigs of *G. kwebensis* are browsed by antelopes and are frequently eaten by elephants.

144. Grewia messinica Burtt Davy and Greenway. Figs. 109a and b.

A leafy, deciduous shrub 6 to 10 feet high, often with one or two well-developed main stems which are, however, twisted and bent. It occurs from the northern and eastern Transvaal lowveld to Swaziland, and is widespread in the Park. It is particularly common around Skukuza and specimens may be seen in the Rest Camp grounds. The leaves are large and oblong, 3 inches or more in length and 1½ to 2 inches wide, often broader above the middle, and with a very lop-sided base. The upper surface of the leaf is glossy dark green and the under surface is felted with a white, velvety mat. Flowers are large, yellow in colour, and appear in large numbers with the young leaves in early summer. The fruits are also large, up to ½ an inch in diameter, borne singly or doubly on short stalks, and consisting of a large stone with a thin, fleshy covering.

145. Grewia monticola Sond. Fig. 109f.

This is another common species in the Park, inhabiting rocky ridges around Punda Maria (a specimen will be seen in the Rest Camp) and found in the large-leaved deciduous bush on grey, sandy soils between Pretorius Kop and Skukuza. Its distribution extends to Bechuanaland, Portuguese East Africa and Swaziland and it is a common species on the Waterberg, Zoutpansberg and Magaliesberg Ranges, showing a distinct preference for rocky situations on quartzite and granite formations. The leaves are oval, tapering to a point, with distinctly toothed margins and very asymmetrical leaf-bases. The upper leaf surfaces are grey-green and rough, while the under surfaces are covered with a whitish felt.

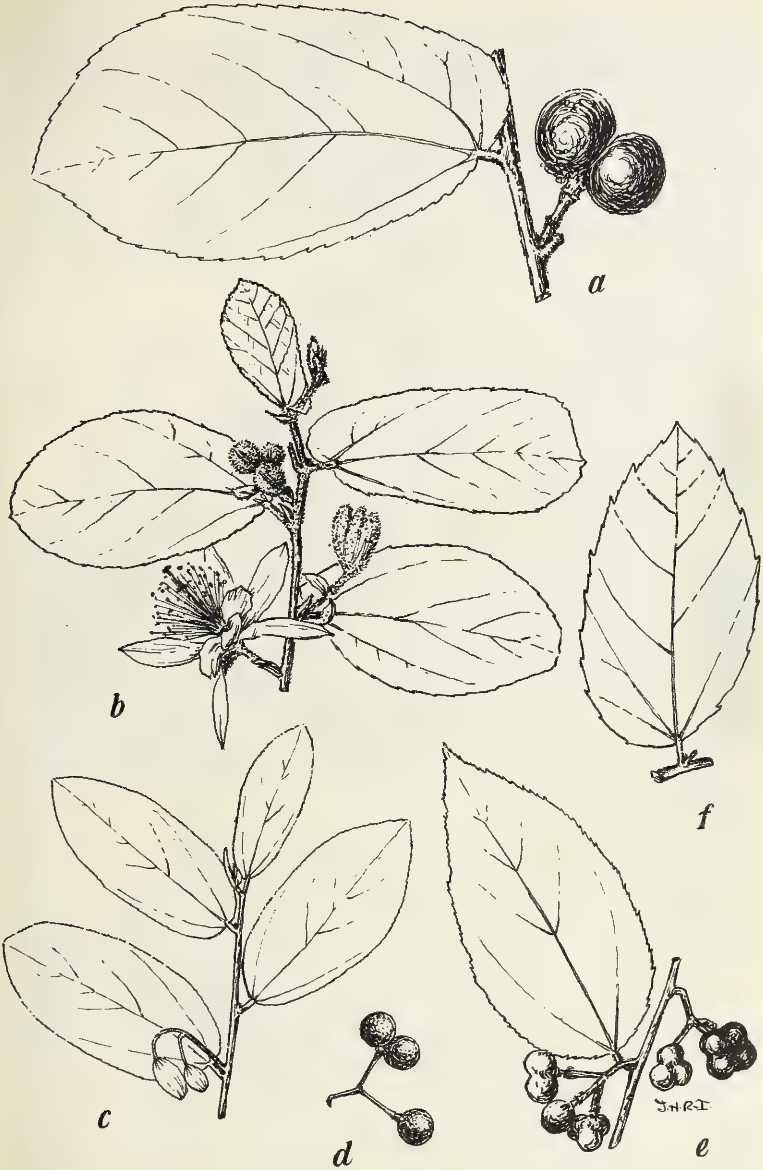


Fig. 109.—Species of *Grewia*, Rosyntjiebos or Kruisbessie. a, *Grewia messinica:* mature leaf and fruit; b, *G. messinica:* young flowering twig; c and d, *G. kwebensis:* flowering twig and fruits; e, *G. flavescens:* leaf and fruits; f, *G. monticola.*

146. Grewia sulcata Mast.

A vigorous, much-branched scrambling shrub which inhabits the evergreen forest fringing the larger rivers in the northern part of the Park, its distribution extending from tropical East Africa to Portuguese East Africa and the Transvaal lowveld. The leaves are oblong, 1½ to 2½ inches long and 1 to 2 inches wide, distinctly broader above the middle, and rounded at the apex. Both leaf surfaces are green in colour and are rough with scattered stellate hairs, while the leaf margins are irregularly toothed. The flowers are fairly large and white in colour and are produced in large numbers towards the ends of the long, supple branches. The fruits are nearly always 4-seeded, giving them the typical "kruisbessie" shape.

147. Grewia villosa Willd.

A several-stemmed shrub growing 3 to 5 feet high, scattered throughout the Park. It has a very wide distribution from Upper Guinea and Abyssinia, throughout tropical Africa and reaching the Transvaal and South West Africa. It is very different from any other species of Grewia with large, round, heart-shaped leaves, green on the upper surface and sometimes greyish below. The upper and lower leaf surfaces, young twigs and fruits are roughly hairy.

MALVACEAE. Cotton and Mallow family.

A large and widespread family which includes some important fibre plants, some attractive garden plants and, also, several garden weeds.

Most members of this family are herbaceous or softly shrubby and there are several species of *Hibiscus* in the Kruger National Park which fall into these categories. There are also a number of species of the related genus *Abutilon,* and one in particular, *Abutilon angulatum* (G. and P.) Mast., is a tall plant up to 6 feet high with large, grey-green, heart-shaped leaves and small apricot-coloured flowers. This species is plentiful on silty alluvial soil along the Letaba and Levubu Rivers. One species with a distinctly woody habit is the Wild Cotton, which is described briefly below.

148. Gossypium herbaceum L. var. **africanum** (Watt) Hutch. & Ghose.
WILD COTTON; RICHINDA (Shangaan); LITJINDA (Swazi).

This is a variety of the cotton that was cultivated in ancient times in the Levant and Turkestan, but which is now largely replaced by cotton varieties of American or hybrid origin. It is scattered in the Kruger National Park and is found in dry bush country from tropical Africa to the Transvaal. It grows as a small shrub or scrambler with slender, woody stems. The leaves are 5-lobed and are roughly hairy. Flowers are of the Hibiscus type, yellow in colour with a deep maroon blotch in the centre of the flower. The fruits ripen in early winter, when the capsules burst open exposing the bunches of white cotton fibre.

BOMBACACEAE. Baobab and Kapok family.

A family of trees, often with large, swollen stems. Some species produce a useful silky cotton from the pods, for instance, the Ceylon Cotton-tree (*Bombax*) and the Kapok (*Eriodendron*). The genus *Adansonia,* to which the Baobab belongs, has a peculiar distribution, with a dozen or so species in tropical Africa and Madagascar, while two species occur in the extreme north-west of Australia.

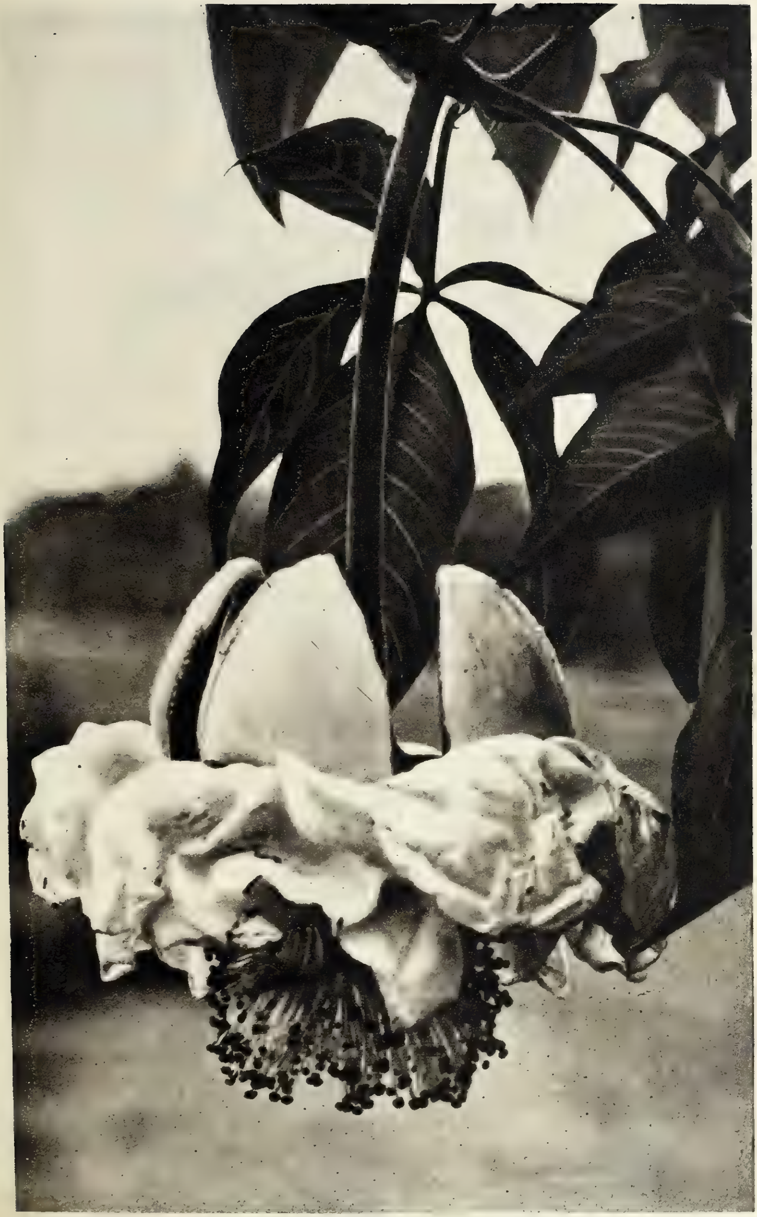


FIG. 110.—*Adansonia digitata,* Baobab flower.

[*Photo by Dr. R. A. Dyer.*

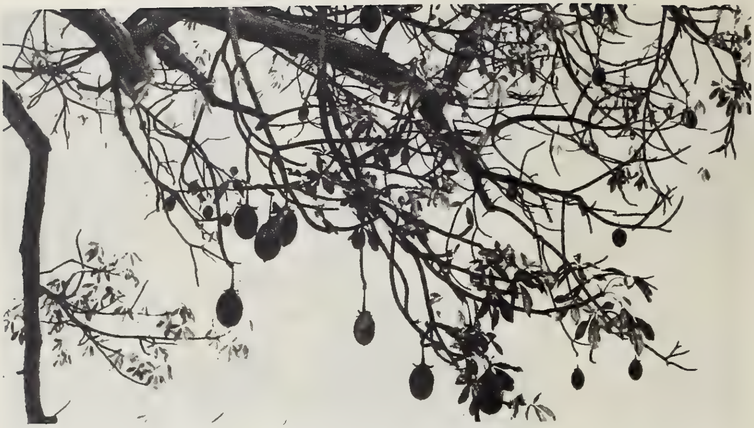


FIG. 111.—*Adansonia digitata*, Baobab fruits.

149. Adansonia digitata L. BAOBAB, CREAM OF TARTAR TREE, MONKEY BREAD, LEMONADE-TREE; SHIMUWU (Shangaan). Figs. 108a, 110, 111 and 112.

The Baobab is a grotesque, deciduous tree with a large, swollen trunk 60 to 70 feet in girth and 40 to 60 feet high. Although it has such a tremendous main stem, the branches taper rapidly, giving it the appearance of holding aloft a number of crooked, stumpy arms.

Baobabs are distributed from Senegal in the west to Abyssinia in the east and, southwards, to Angola and into the northern and north-eastern Transvaal. Dr. John Hutchinson in *A Botanist in Southern Africa* says that nowhere has he seen them in such quantity as on the northern slopes of the Zoutpansberg and the adjoining flats.

In the Kruger National Park several Baobab trees occur on the stony slopes towards Pafuri and an isolated tree may be seen near the Gorge Rest Camp. Another, probably the most southerly in the Park, is a landmark on the south bank of the Olifants River, near the small Olifants River Rest Camp. It may be noted that Baobabs occur at even more southerly latitudes in Portuguese East Africa.

The leaves of the Baobab are dark green and are digitately divided, which means that they consist of 5 to 7 long, narrow leaflets radiating from a central point, on the end of a longish leaf-stalk. The large, pendulous, gardenia-white flowers appear in October or November and are 5 or 6 inches in diameter. They consist of 5 reflexed, silky sepals and 5 broad, crinkled petals, waxy white when freshly open, but soon becoming brown and discoloured before being shed. The numerous stamens are united on a central column and are shed with the petals.

The fruit is oblong or egg-shaped, 5 or 6 inches or more in length and 3 to 4 inches in diameter, with a woody shell which is softly grey-velvety on the outside. The fruits fall in April or May when they are ripe and are invariably torn open by baboons for their edible contents. Inside the shell are a number of seeds embedded in a whitish pulp, which is brittle when dry and, if mixed with water, gives a refreshing drink. The dried pulp has been called " cream of tartar " and this is supported by analysis, which shows the presence of an appreciable amount of free tartaric acid and potassium bitartrate.

The wood of the Baobab is soft and spongy and is of no use except, perhaps, for making paper pulp. Although it is often stated that the older trees must be thousands of years old, such an estimate is, without doubt, an exaggeration, though their ages probably run into hundreds of years. In the Messina and Dongola areas, many young Baobabs may be seen, while old trees periodically collapse in a spectacular heap of fibrous pulp. A seedling planted at Dongola by Dr. I. B. Pole Evans fifteen years ago is already 25 feet high, with a trunk diameter of 3 to 4 feet. Cultivated Baobabs of considerable size are also found in Ceylon and the East Indies where they are thought to have been brought by Arab traders.

STERCULIACEAE. Sterculia family.

This family is distributed throughout the world and comprises a large number of species of trees, shrubs and herbs. Probably the most important member economically is the Cacao tree of tropical America (*Theobroma cacao*), the source of commercial cocoa and chocolate. Another interesting product is the Cola nut (*Cola acuminata*) of West Africa, which is chewed by the natives when undertaking an arduous journey. The increased powers of endurance which the nut imparts is due to the high caffeine content.

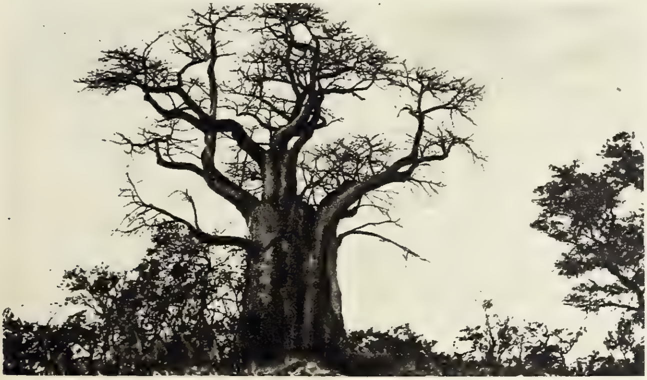
The most important woody genera in South Africa are *Dombeya* and *Sterculia*, both represented in the Kruger National Park by two species which are described below. In addition there are several low, soft shrubs of other genera, such as *Waltheria americana* L. var. *indica* K. Schum, and a few species of *Melhania*.

150. Dombeya rotundifolia (Hochst.) Harv. WILD PEAR; DIKBAS, DROLPEER; SHILUVARHI, NSIHAPHUKUMA (Shangaan); UMBIKANYAKA (Swazi). Fig. 113.

The genus is named in honour of Joseph Dombey, a French botanist and traveller in South America.

The Wild-pear is a deciduous small tree of the Transvaal, Natal, Bechuanaland and Rhodesian bushveld, and is found in the Kruger National Park chiefly south of the Sabi River (a tree stands in the Pretorius Kop Rest Camp grounds) and on rocky hillsides near Punda Maria.

FIG. 112.—*Adansonia digitata*, Baobab, near Pafuri.



It is one of the first trees to flower in spring, usually long before the first rains, and the Swazi name appropriately means " the tree that heralds the new season ". The trees are conspicuous for a short time, with their masses of white flowers giving the impression of flowering plum or pear trees. Unfortunately, the flowering period is very short and the flowers soon turn brown and fall. The fruits are small, ovoid and dark coloured, somewhat resembling goat droppings. The leaves appear after the flowers and are almost round in shape, about 2 to 3 inches broad, rough to the touch, with a conspicuous network of veins.

Galpin reports that the wood is bluish-grey, heavy, strong and exceedingly tough and cross-grained. It is looked upon as a good timber for wagon building, but the stems are rarely straight enough or sufficiently large to provide suitable pieces.

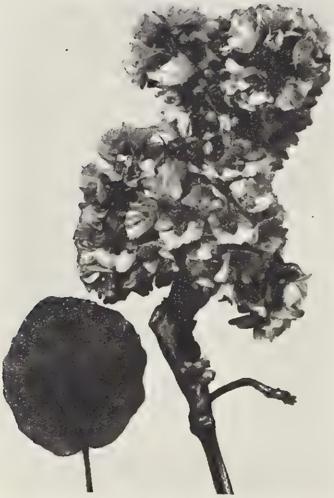


FIG. 113.—*Dombeya rotundifolia*, Wild Pear: leaf and flowering twig. [*Photo by H. King*.

151. Dombeya cymosa Harv.

A small slender tree of wooded kloofs in the southern part of the Park. The leaves are smaller and thinner textured than those of *D. rotundifolia* and are more or less heart-shaped. The flowers are also smaller and have a pale, pinkish-white colour.

152. Sterculia murex Hemsl. LOWVELD CHESTNUT; UMBHABA (Swazi). Figs. 114, 115 and 116.

The genus is named after the god Sterculius, the derivation being from the Latin *stercus*, manure, on account of the odour of leaves and fruits of some species.

The Lowveld Chesnut is a deciduous tree up to 30 feet high inhabiting dry, rocky situations in the eastern Transvaal lowveld and occurring in the Kruger National Park around Pretorius Kop and Malelane. One or two trees of this species have been planted in the Skukuza Rest Camp and are making rapid growth.

The dark green leaves are digitately divided into 5 to 7 narrow leaflets, radiating at the end of a long leaf-stalk. The yellow-brown, waxy flowers are borne in slender sprays at the ends of the thickish, brittle branches in September or October while the trees are completely leafless. They are saucer-shaped, about ¾ of an inch across with five lobes, and are formed by the five sepals uniting, the petals being entirely absent. The fruit is one of the strangest of all lowveld species. In the flower, the ovary consists of five lobes which enlarge and separate as the fruit ripens, developing eventually into 1 to 5 large pods, each with a hard, spiny covering (Fig. 115). The pods split open forming a boat-shaped shell exposing a number of oval, chesnut-like seeds, usually covered with a sprinkling of stinging hairs from the inside of the pod. The seeds contain a good deal of oil and appear to be eaten by wild animals, as

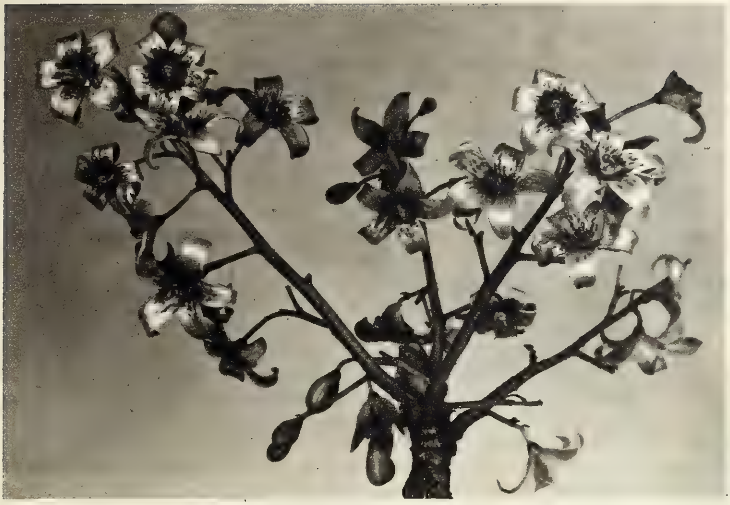
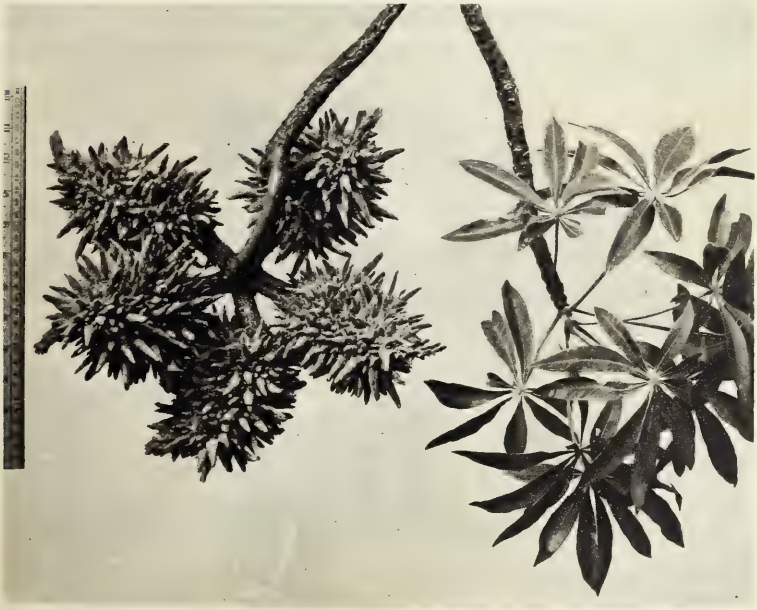


Fig. 114.—*Sterculia murex,* Lowveld Chestnut: flowering branch, × ½.
[*Photo by H. King.*

Fig. 115.—*Sterculia murex,* Lowveld Chestnut: branch showing leaves and fruits, much reduced.
[*Photo by H. King.*



it is difficult to find seeds under the trees. After removal of the seeds, the boat-shaped, woody shells of the pod may be used as unusual ash-trays. The bark of the tree is rough and black, while the wood is soft and of no value.

153. Sterculia rogersii N.E. Br. SAMANI (Shangaan). Fig. 117.

This species is very different in appearance from the preceding, being a thick-stemmed shrub or small tree up to 15 feet high. The stem has a soft, almost succulent appearance and is 1 to 2 feet thick at the base, often forking near the ground level and tapering rapidly. In appearance it resembles a Corkwood (*Commiphora*) or a young Baobab, but the bark is smooth with a patchy, red and grey appearance. The species is scattered throughout the Park, usually on rocky outcrops, and a specimen will be seen on the wooded hillside in the Punda Maria Rest Camp.

The leaves are usually three-lobed, about 1½ inches long and 1 inch broad at the base, borne on slender leaf-stalks and are shed early in autumn. The flowers are similar to those of the previous species, but are only ½ an inch in diameter and are produced close to the leafless stems. The fruit consists of 1 to 5 small, pod-like lobes, about 2 to 2½ inches long, with a thin, hard shell and no spines on the outer surface. The pods burst open along one side exposing a number of seeds the size of small peas, surrounded by short, stiff, stinging hairs.

OCHNACEAE. Ochna family.

One genus, *Ochna*, is found in South Africa and is represented in the Kruger National Park by three species. The generic name is derived from *Ochne*, the Greek name of a wild pear.

154. Ochna pulchra Hook.f. LEKKERBREEK, BARNARDGIF; NZOLOLO (Shangaan). Plate IVa (page 98).

A very ornamental, deciduous small tree which is common on the Magaliesberg, Waterberg and Zoutpansberg Ranges and which occurs on the sandy flats near Punda Maria. It is also recorded from Rhodesia and Angola.

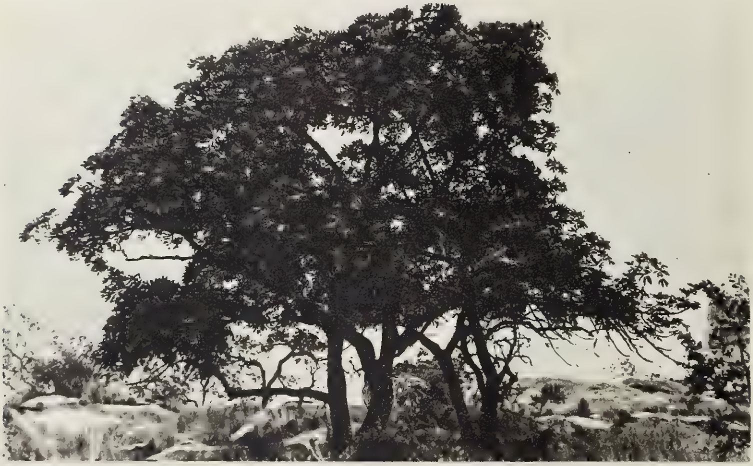


FIG. 116.—*Sterculia murex*, Lowveld Chestnut, on Shabin Kop near Pretorius Kop.

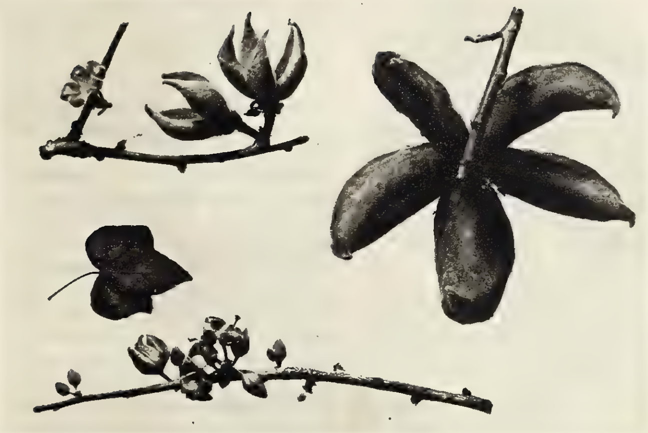


FIG. 117.—*Sterculia rogersii,* Samani: showing young fruits, flowers, leaf and mature fruits, × ½.

[*Photo by H. King.*

The trunk is rather twisted, with a smooth, grey and white mottled bark. The spring foliage is brightly coloured in light green and bronze shades and appears at the same time as the sprays of ornamental flowers. The petals are small and are shed soon after the flowers open, but the sepals, which are green at flowering time, enlarge and turn bright red. Protruding above the sepals is the oval fruit, like a small olive, which changes from pale green to black, producing a most striking colour contrast [Plate IV (*a*), page 98].

The thin fleshy covering of the fruit is said to be edible, while an oil may be expressed from the seeds. The wood is tough and close-grained, light brown in colour, but is apt to crack.

155. Ochna natalitia Engl. & Gilg.

A deciduous shrub growing to 5 or 6 feet high, scattered in the southern part of the Park and found also in the sandveld around Punda Maria. The flowers are bright yellow and make an attractive show in spring.

156. Ochna pretoriensis Phillips.

This is a similar species to the preceding one, making a low, bushy growth 3 or 4 feet high. It occurs in bush groups around Pretorius Kop and is inconspicuous for most of the year but, as in the previous species, produces a quantity of pretty yellow flowers in spring before the young leaves.

GUTTIFERAE. Mangosteen family.

This family includes some useful timber trees and edible fruits, for example, the Mangosteen (*Garcinia mangostana* L.) and Mammee-apple (*Mammea americana* L.), while the Gamboge of commerce is obtained from the yellow, resinous gum of *Garcinia morella.* One species, the African Mangosteen (*Garcinia livingstonei*), occurs in the Kruger National Park. The name Garcinia commemorates Lawrence Garcin, botanical writer and collector in India in the eighteenth century.

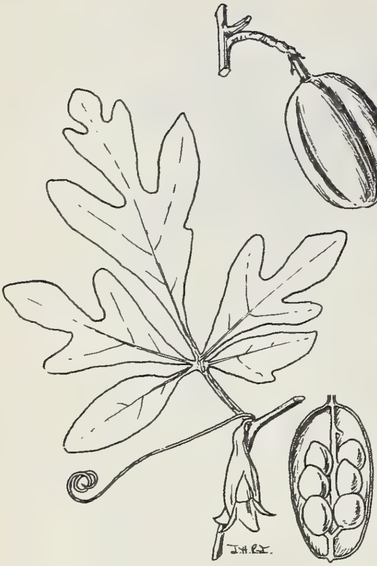


FIG. 118.—*Adenia digitata*, Bobbejaangif, × ¾.

157. Garcinia livingstonei T. Anders. AFRICAN MANGOSTEEN; MHIMBI (Shangaan).

This species extends from Nyasaland to the Transvaal lowveld and varies in habit from a twiggy shrub 3 to 4 feet high in the south of the Kruger National Park, to a much-branched tree 30 feet high along the Levubu River, where a good specimen will be seen in the Pafuri Rest Camp.

The branching is characteristic with short, stiff branchlets radiating in threes from the main stems, while the leathery, oblong leaves, 2 to 3 inches long and 1 to 1½ inches broad, are arranged in opposite pairs, or in threes. The flowers, which are small and scented, are borne close to the stems. The fruits are ovoid, orange coloured when ripe, and consist of a smooth stone surrounded by a pleasant-tasting, sweet-acid pulp, which is distinctly refreshing on a hot day.

The wood is yellowish white, of medium texture and weight and is susceptible to borer attack.

FLACOURTIACEAE. Kei-apple family.

A small family of trees or shrubs, found in all warm countries. The best known South African representative is the Kei-apple (*Dovyalis caffra*), which is cultivated as far afield as Australia, California and the Mediterranean as a hedge plant and for its edible fruit. Only two members of the family have been collected in the Park, an unnamed species of *Homalium* from Ship Mountain and wooded hills near Malelane, and *Flacourtia hirtiuscula*. The last named is briefly described below.

158. Flacourtia hirtiuscula Oliv. UMTABHALA (Swazi).

A spiny shrub or small tree growing to about 10 feet high, which occurs in wooded places in the southern parts of the Park. It is also found in Bechuanaland, Southern Rhodesia, Portuguese East Africa and Nyasaland.

The leaves are oval and firm textured, about 1½ to 2 inches long and 1 to 1½ inches broad with a distinctly toothed (crenate) margin, and may be softly hairy or smooth. The flowers are small and inconspicuous, while the fruit is a round, edible berry about ¾ of an inch in diameter. It is dark coloured when ripe, with several seeds embedded in a firm pulp which is said to have a pleasant taste.

PASSIFLORACEAE. Granadilla family.

A family of herbs, shrubs, trees and climbers, including the well-known genus *Passiflora*, to which the Granadilla or Passion-fruit belongs. The most important South African genus is *Adenia*, of which four species have been found in the Kruger National Park, including the extremely poisonous *Adenia digitata* (Bobbejaangif).

159. Adenia digitata (Harv.) Engl. BOBBEJAANGIF. Fig. 118.

This species has a swollen, underground tuber with slender, twining stems provided with tendrils. It is scattered throughout the Park and is widespread in the Transvaal, occurring also in Southern Rhodesia and Bechuanaland.

The leaves are deeply lobed and divided, are greyish green in colour and are completely smooth. The flowers have a bell-shaped, five-lobed calyx, whitish in colour or tinged with mauve, the male and female flowers occurring separately. The fruit is oblong or roundish, about 1½ inches long and 1 inch in diameter with a firm skin which is yellow or orange when ripe. The fruit is composed of three partly hollow compartments containing a number of seeds which are embedded in a soft, pulpy substance. The fruits are attractive, especially to children, and are said to have a pleasant flavour, but several deaths are known to have occurred as a result of the fruits having been eaten. The tubers are also extremely poisonous, containing at least two poisons, a cyanogenetic glucoside and a toxic substance named *modeccin*.

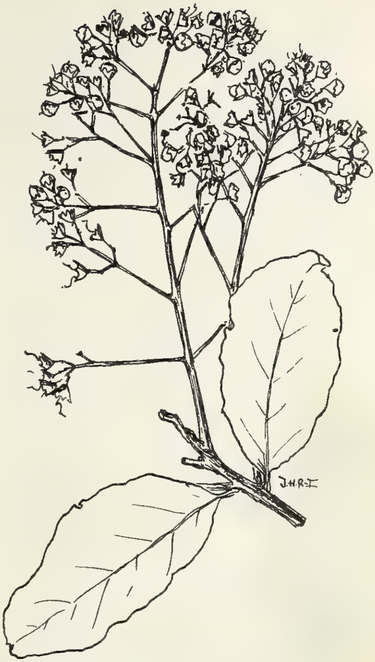


FIG. 119.—*Galpinia transvaalica*, Galpinia, × ¾.

160. Adenia hastata (Harv.) Schinz.

This species has been collected in the neighbourhood of Skukuza. It has a similar habit of growth to the preceding species, but the leaves are broadly triangular in shape and are not deeply lobed. The fruits are said to be edible.

161. Adenia gummifera (Harv.) Harms. DOVOSHA (Shangaan).

A robust, much-branched climber which inhabits well wooded places near Punda Maria and has been seen in the extreme south near Malelane. It grows over trees to a height of 25 feet or more and the stems, which have a pallid green colour, develop to 9 inches thick near the base. The leaves are large, broader than long and are 3-lobed, though sometimes the lobing is not very marked.

162. Adenia spinosa Burtt Davy.

This species has a massive, swollen, succulent stem most of which is above the ground and has a greenish colour. From this enlarged stem arise slender twining branches which are armed with straight, sharp spines. Numerous creamy-yellow flowers appear on these branches before the leaves in early summer. The species inhabits rocky situations and has been found on the Lebombo Range.

LYTHRACEAE. Pride of India family.

A large and widespread family of herbs, shrubs and trees, some of which have medicinal uses, while others are noted for their attractive flowers, for example, the Pride of India or Crape Myrtle (*Lagerstroemia indica*). Other species are useful as sources of dyestuffs or timber. Only one woody species, *Galpinia transvaalica*, is found in the Kruger National Park. The genus is named after Dr. E. E. Galpin, famous for his interest in South African plants and referred to by General Smuts as " the prince of South African collectors ".

163. Galpinia transvaalica N.E.Br. GALPINIA. Fig. 119.

There is only one species in this genus and it has a limited distribution in the eastern Transvaal lowveld and Portuguese East Africa. It may be seen in the Malelane area but is never very common.

It is a leafy, almost evergreen shrub or small tree up to 10 feet high. The leaves are glossy dark green and oval in shape, 1½ to 2 inches long and about 1 inch wide. Flowers are white and are produced in showy bunches at the ends of the branches in the manner of the cultivated Pride of India, but the flowering period only lasts a short time. The flowers are followed by clusters of small, round, capsular fruits, each containing several flat, papery seeds.

COMBRETACEAE. Combretum family.

A tropical and sub-tropical family of trees, shrubs and climbers, often with hard and heavy wood, and used in some cases for tanning and dyeing. Some of the climbers are very ornamental when in flower. The family plays an important part in the vegetation of the Kruger National Park and certain species, such as the Rooibos or Red Bush-willow (*Combretum apiculatum*), may be dominant over large areas. The two main genera in the Park are *Combretum* and *Terminalia*, though another small tree of this family, *Pteleopsis myrtifolia* Engl. & Diels has recently been collected near Punda Maria.

Combretum.

The name Combretum was used by Pliny for a climbing plant of this family. There are now more than 250 species of *Combretum* recognised, distributed in most tropical and sub-tropical regions, and about 20 of these occur in the wooded parts of South Africa.

The following 11 species have been found in the Kruger National Park: *Combretum apiculatum, C. celastroides, C. gazense, C. glomeruliflorum, C. gueinzii, C. imberbe, C. microphyllum, C. mossambicense, C. suluense, C. transvaalense* and *C. zeyheri*. They vary in habit from straggly shrubs to trees and woody climbers and all bear the characteristic dry, 4-winged fruits, though there may be much variation in size between the fruits of different species. The flowers are small, clustered in roundish or elongated spikes usually whitish or cream-coloured. In one species, however, (*C. microphyllum*, the Flame Creeper), the flowers are bright, glowing scarlet.

164. Combretum apiculatum Sond. RED BUSH-WILLOW; ROOIBOS; SHIKUKUTSU (Shangaan); INKUKUTU (Swazi). Fig. 120a.

This is a small, deciduous tree, 15 to 20 feet high, which is a common constituent of the Transvaal bushveld and is usually the predominant species on the reddish, gravelly, granitic soils, where the rainfall is in the neighbourhood of 15 to 20 inches per annum. These conditions of soil and climate prevail along the western side of the Park from the Sabi to the Shingwedzi Rivers, and it is in this region that the Red Bush-willow is particularly common. Specimens may be seen in the Gorge and Punda Maria Rest Camps. The tree is also found in Natal, Portuguese East Africa, Rhodesia, Bechuanaland and South West Africa.

The leaves are a shiny yellowish green, oval in shape, about 2 to 3½ inches long and 1½ to 1¾ inches broad, tapering abruptly to a point and they turn yellow-brown in autumn before they fall. They are thin textured with conspicuous veins on the under surface and are completely smooth (glabrous). Flowers appear in short, creamy-yellow spikes in early summer. The four-winged fruits are about ¾ of an inch long, turning reddish as they mature, and often persisting on the trees until after the leaves are shed. The Red Bush-willow is looked upon as a valuable fodder tree, though it is noticeable that the leaves are not eaten until they have fallen, or are on the point of falling.

The trunk is usually twisted and rarely reaches 12 inches in diameter. The wood is very strong, close-grained and resistant to termites. The The black heart-wood contrasts attractively with the yellowish-white sapwood, but the wood is too hard to work for furniture.

165. Combretum celastroides Welw. ex Laws.

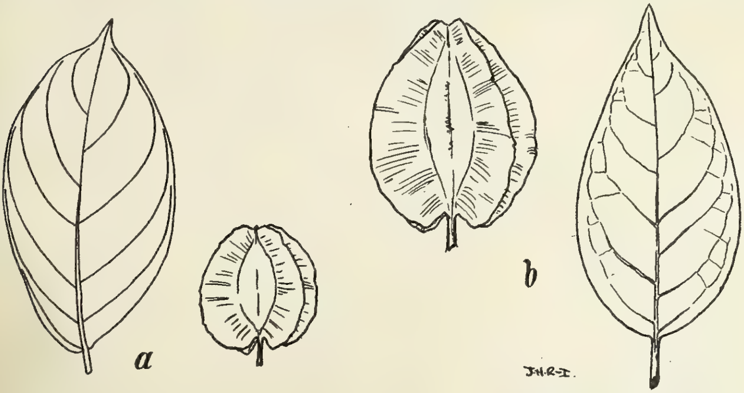
A straggly shrub of wooded, rocky ridges in the northern part of the Park around Punda Maria and is never an important constituent of the vegetation. The flowers are in slender, creamy spikes, while the fruits are amber-coloured and small, about ½ an inch in length.

166. Combretum gazense Swyn. & Bak. RHODESIAN BUSH-WILLOW. Fig. 120b.

A small tree up to 15 feet high, resembling the Zulu Bush-willow in stature and fruit character and it may be noted that the Shangaans employ the same name "Mvuva" for both species. The feature which distinguishes it is the white felt on the under surface of the leaves. The leaves are large, narrowly oval, 4 to 5 inches long and 2 inches wide. The four-winged fruits are also fairly large, about 1½ inches long, tapering slightly to the apex, and are reddish brown when mature.

The Rhodesian Bush-willow is found on the sandy flats around Punda Maria and extends from the Zoutpansberg Range to Rhodesia.

FIG. 120.—a, *Combretum apiculatum*, Red Bush-willow or Rooibos: leaf and fruit. × ¾; b, *C. gazense*, Rhodesian Bush-willow, × ¾.



167. Combretum glomeruliflorum Sond. BUSH-WILLOW; VADERLANDSWILG. Fig. 121a.

A densely leafy small tree found along rivers in the Transvaal, Orange Free State and Cape Province and, in the Kruger National Park, is plentiful along the Sabi River. The leaves are lance-shaped, 2½ to 3 inches long and about an inch broad, and they develop attractive autumn shades before being shed. The fruits are comparatively small, being little more than ½ an inch long.

168. Combretum gueinzii Sond. VELVET-LEAF BUSH-WILLOW; BASTER-ROOIBOS; INKUKUTWANE (Swazi). Fig. 121b.

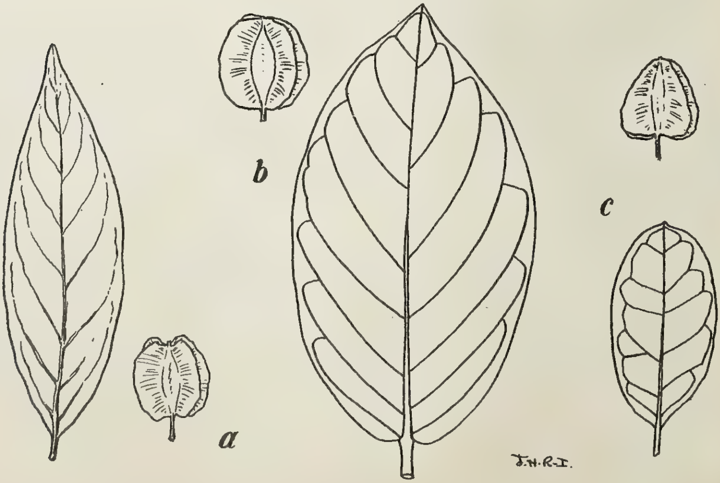
A small tree up to 15 feet in height which inhabits the large-leaved deciduous bush zone around Pretorius Kop and is found on rocky situations near Punda Maria. A tree may be seen in the Pretorius Kop Rest Camp. It is common on the Magaliesberg, Waterberg and Zoutpansberg Ranges and is found in Rhodesia, Portuguese East Africa and east and west tropical Africa. The leaves are about the same size as those of the Red Bush-willow, but are dark green and velvety and turn reddish shades in autumn. The four-winged fruits are also about the same size, being approximately ¾ of an inch long. Some specimens in the Park have leaves velvety on both surfaces, therefore answering the description of *C. holosericeum* Sond., but I do not consider this species to be specifically distinct from *C. gueinzii* Sond.

169. Combretum imberbe Wawra. LEADWOOD; HARDEKOOL; MMONDZO (Shangaan); UMMONDO (Swazi). Fig. 121c.

This is a characteristic species of the Park, growing as a shrub or a handsome tree up to 50 feet in height. It occurs usually on the better types of soil, often in shallow depressions or on river banks, and trees may be seen in the Pafuri, Letaba, Satara, Malelane and Pretorius Kop Rest Camps. The species is also widespread in tropical Africa.

The bark is pale grey, striated and cracked into small rectangles, and the young branches are also whitish coloured. The leaves are small and pale grey-green, 1 to 1½ inches long and ¾ of an inch wide, often slightly broader above the middle, and the leaf-margins are frequently wavy. There are no hairs on the leaves, but if the underside of a leaf is examined with a hand-lens, it will be seen that it is densely covered with minute

FIG. 121.—a, *Combretum glomeruliflorum*, Bush-willow or Vaderlandswilg: leaf and fruit, × ¾; b, *C. gueinzii*, Velvet-leaf Bush-willow or Baster Rooibos: fruit and leaf, × ¾; c, *C. imberbe*, Leadwood or Hardekool: fruit and leaf, × ¾.



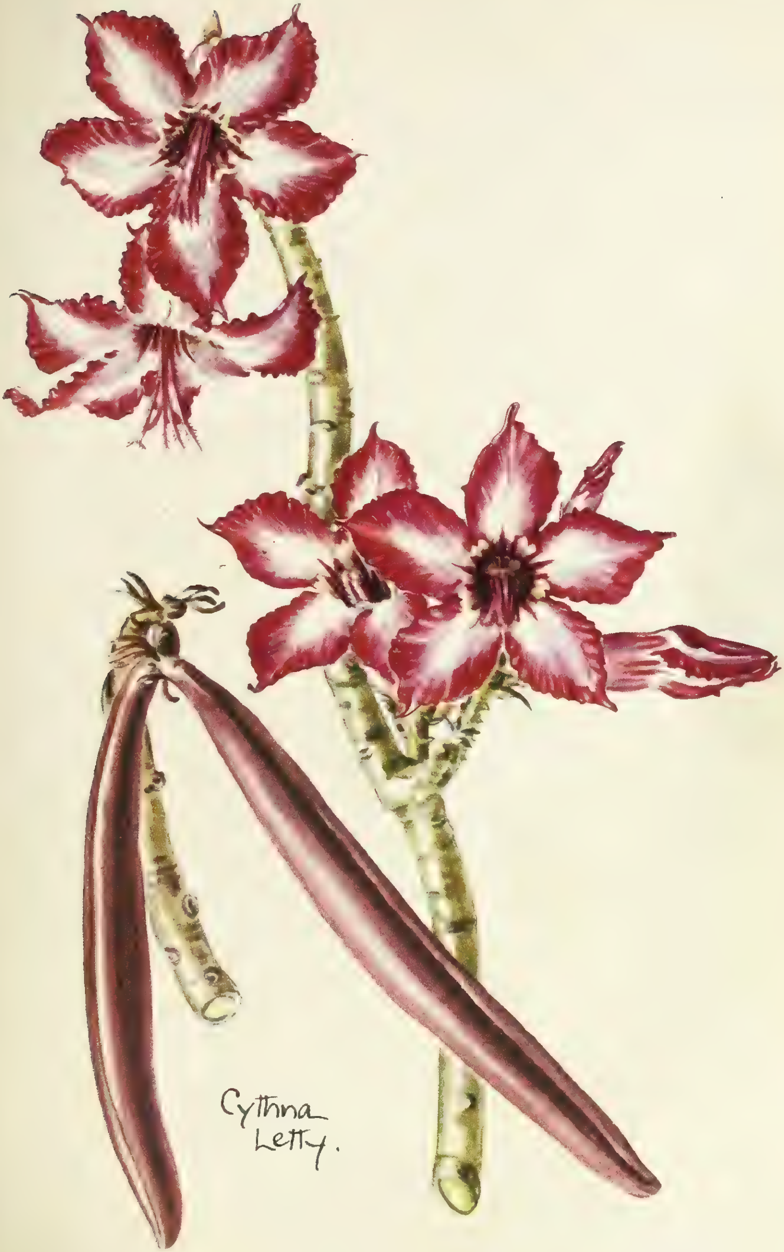

Cythna Letty.

Plate V.
Adenium multiflorum, Impala Lily (see page 151).

round scales like miniature sequins of silver and gold. The four-winged fruits are small, being about ½ an inch long and of equal width, and are yellow-green when mature.

The wood is chocolate coloured with a thin layer of whitish sap-wood, and has an attractive grain when polished. It is exceedingly hard, heavy and durable, too difficult to work for furniture, but is outstandingly suitable for ornaments, small pedestals, book-ends etc. Sim states that the wood of the Leadwood was used by natives for hoes before the advent of iron hoes. The timber is used at present for fencing posts, mine-props and sleepers and it is a great pity that the larger trees have been extensively exploited for these purposes.

Another common use of the wood is for fuel, for which purpose it is well suited, retaining the heat for a long time. The ash has a high lime content and has been used as a substitute for lime in white-washing.

The name *C. imberbe* var. *petersii* has been applied to our South African Leadwood but it may be noted that the authorities at Kew now consider that the various forms are not sufficiently distinct to maintain as separate varieties.

170. Combretum microphyllum Klotzsch. FLAME CREEPER, BURNING BUSH; MPFUNTA (Shangaan). Fig. 122a.

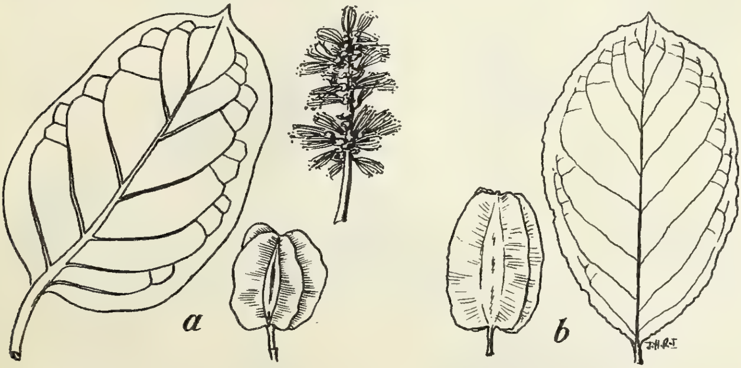
A vigorous, woody climber, growing usually on river banks throughout the Park and covering even some of the larger trees. A good specimen may be seen in the Punda Maria Rest Camp, near the office.

The small red flowers are massed in short spikes, and these are produced in abundance at the ends of the climbing branches in spring, so that the trees on which the creepers grow become festooned with scarlet flowers. The flowers appear before the leaves, or together with the young leaves. Later on the leaves grow to about 2½ to 3 inches long and 1½ to 2 inches wide. The four-winged fruits are relatively small, about ¾ of an inch long, whitish green in colour, with a thin, papery texture.

171. Combretum mossambicense (Kl.) Engl. MOCAMBIQUE COMBRETUM; KHULAVUSIKU (Shangaan). Fig. 122b.

A straggly shrub, sometimes producing slender, twining branches, but rarely reaching a height of more than 15 feet. It is scattered throughout the Park and a plant may be seen near the bathrooms in the Punda Maria Rest Camp. It is also found in Ngamiland and the Rhodesias.

FIG. 122.—a, *Combretum microphyllum*, Flame Creeper: leaf, flower-spike and fruit, × ¾; b, *C. mossambicense*, Mocambique Combretum: fruit and leaf, × ¾.



For the greater part of the winter the plants are leafless but, in early summer, they produce a mass of whitish-pink flowers. The leaves appear after flowering has ceased and, when mature, they are oval, roughly veined and about 2 to 2½ inches long and 1½ to 1¾ inches broad. The fruits are fairly large, about 1 to 1¼ inches long and ¾ of an inch broad, and are also of a whitish-green colour.

172. Combretum suluense Engl. & Diels. ZULU BUSH-WILLOW; MVUVA (Shangaan); LIFUFU (Swazi). Figs. 123a and b, 124.

A small tree, rarely exceeding 20 feet in height, which is an important constituent of the large-leaved bush found on the greyish, sandy soils between Pretorius Kop and Skukuza. It has also been found near Punda Maria, where it might be confused with the somewhat similar species, *C. gazense*. Apart from the Transvaal lowveld, it is recorded from Swaziland and Portuguese East Africa.

The leaves are large and narrowly oval, often broader above the middle and they lack the white, felted under-surface shown by *C. gazense*. Like many Combretums, however, the under-surface of the leaf is covered with minute scales, like miniature sequins of grey and gold. The four-

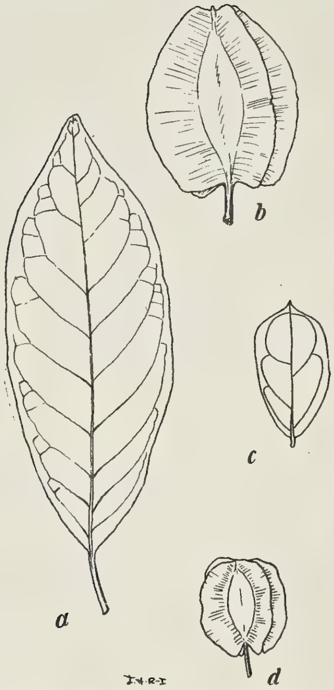
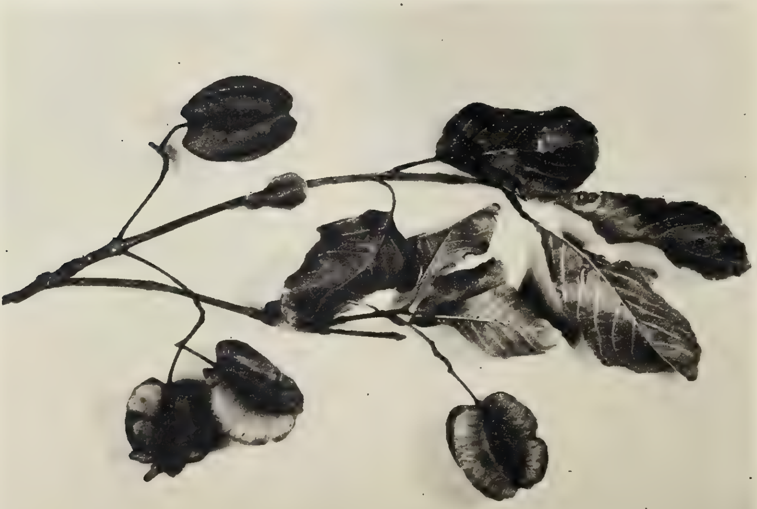


FIG. 123.—a and b, *Combretum suluense*, Zulu Bush-willow: leaf and fruit, × ¾; c and d, *C. transvaalense*, Russet Bush-willow or Kierieklapper: leaf and fruit, × ¾.

FIG. 124.—*Combretum suluense*, Zulu Bush-willow: fruiting branch, × ¼.
[*Photo by J. Raeburn.*



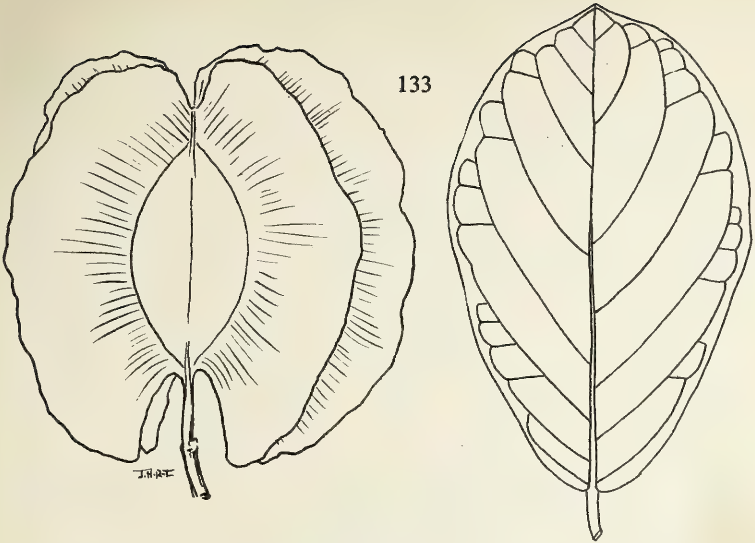


FIG. 125—*Combretum zeyheri*, Zeyher's Bush-willow: fruit and leaf, × ¾.

winged fruits closely resemble those of *C. gazense*, being about 1½ inches long, often tapering slightly towards the apex, with a reddish-brown colour when mature.

The trunk is usually twisted and the bark has a smooth, greyish appearance. Nothing is known of the quality of the wood and pieces of timber size are rarely found. The leaves turn pale yellow in autumn before being shed and do not appear to be eaten as is the case with the Red Bush-willow.

173. Combretum transvaalense Schinz. RUSSET BUSH-WILLOW; KIERIEKLAPPER, SHIKHAVI. MPOTSA (Shangaan); SIHLALAVANE (Swazi). Plate IVb (page 98); Figs. 123c and d.

A common shrub or small tree of the Transvaal bushveld, extending to Swaziland, Rhodesia and Portuguese East Africa. It is scattered throughout the Park, where it usually grows on stream banks and in brackish situations. Specimens may be seen in the Skukuza, Shingwedzi and Malelane Rest Camps.

The leaves are smallish, ¾ to 1¼ inches long and about ½ an inch broad, dark glossy green above, and yellow-green to rusty below, with conspicuous veins on the under surface. The flowers are in small creamy spikes and the four-winged fruits are about an inch long and ¾ of an inch broad. The fruits are a rich, russety brown, often borne in dense clusters, making this one of the showiest species in the lowveld during autumn or winter.

The wood is hard and strong with a dark brown colour. It has a twisted grain, however, and straight pieces of sufficient size to be of use are rarely found.

174. Combretum zeyheri Sond. ZEYHER'S BUSH-WILLOW; RAASBLAAR, NICHOLAS-KLAPPER; MAFAMBA-A-BORILE (Shangaan). Fig. 125.

A tree of 20 to 25 feet in height with spreading branches, common in the Transvaal bushveld, especially on the poorer, sandy soils. It is also found in Nyasaland, Angola, Portuguese East Africa and Rhodesia. In the Kruger National Park it occurs in the large-leaved bush south of the Sabi River, together with the Zulu Bush-willow (*C. suluense*). It is also found around Punda Maria and a well-grown specimen may be seen in the Rest Camp.

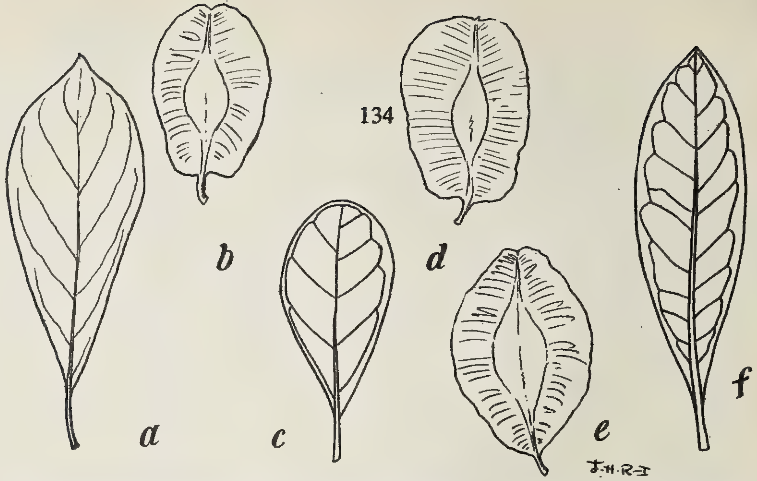


FIG. 126.—Leaves and fruits of *Terminalia* species. a and b, *T. phanerophlebia;* c and d, *T. prunioides,* Lowveld Terminalia or Sterkbos; e and f, *T. sericea,* Silver Terminalia or Vaalboom. All × ¾.

The tree is remarkable for its very large, four-winged fruits, as much as 2 to 2½ inches long and equally broad, which are light brown in colour when mature. The leaves are large, oval-oblong in shape, often broader above the middle, 2½ to 4 inches long and 1½ to 2 inches broad, often slightly hairy when young, but becoming smooth with age. They are thin textured, with prominent veins on the under surface, and turn pale yellow in autumn before being shed.

The wood is yellowish, intermingled with brown and is easily worked, but is not durable unless thoroughly seasoned, a fact that is stressed by the native name.

Terminalia.

The name is derived from the Latin *terminus,* end, the leaves tending to be produced in bunches at the ends of the branches. Although nearly as large a genus as *Combretum* with about 200 species in all, only 4 species occur in South Africa. Three of these have been recorded from the Kruger National Park, namely: *T. phanerophlebia, T. prunioides* and *T. sericea.* All three have the characteristic oval, shield-shaped, dry fruits, thickened in the centre by the solitary seed, which is surrounded by a flat, wing-like border. The fruits of *T. prunioides* turn a striking purple-maroon colour in autumn.

175. Terminalia phanerophlebia Engl. & Diels. Figs. 126a and b.

This is a small tree found somewhat rarely in the Malelane section along wooded water-courses, and is nowhere plentiful. As well as the eastern Transvaal lowveld, it is found in Zululand and Portuguese East Africa.

176. Terminalia prunioides Laws. LOWVELD TERMINALIA; STERKBOS; SHASHANDZAWU (Shangaan). Plate IVc (page 98); Figs. 126 and 127.

A dense shrub growing up to 15 feet high with drooping, twiggy branches. It is found throughout the Park, showing a distinct preference for the drier situations, such as the Mopane and Red Bush-willow veld types. In the southern part of the Park, it occurs along dry water courses, being noticeably absent from the large-leaved bush around Pretorius Kop. Specimens may be seen in the Crocodile Bridge and Gorge Rest Camps. It is a common species in the low country north of the Zoutpansberg and is recorded also from Portuguese East Africa, Ngamiland and Angola.

While not strictly evergreen, the leaves are shed irregularly, and withered leaves may persist on the trees for most of the winter. The leaves are dark green, 1 to 1½ inches long and ¾ of an inch broad, distinctly wider towards the top, and are borne in tufts on the twiggy, almost spiny branchlets.

Flowers are small and whitish and are borne in slender spikes, which are produced in great quantity in mid-summer. They have an unpleasant smell, which taints the air for some distance. The leathery fruits are oval and are thickened in the centre by the single seed and are about 1½ inches long and 1 inch broad. They are a deep reddish-purple to maroon colour when mature, making the plants conspicuous in the autumn and winter months.

The bark on the younger branches is brown and stringy. The wood is very hard and tough and is one of the best for use as implement handles, hence the common name "Sterkbos". It also makes a good fuel.

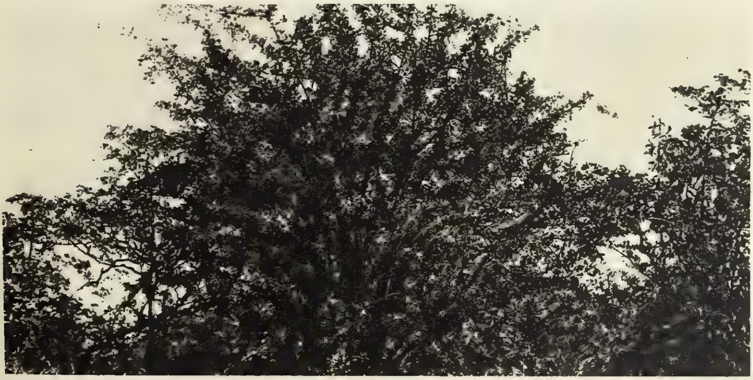
177. Terminalia sericea Burch. SILVER TERMINALIA; VAALBOOM, SANDGEELHOUT; NKONONO, NKONOLA (Shangaan). Figs. 126e and f.

A tree with attractive, silvery foliage, growing up to 35 feet high, and occurring throughout the Park. In contrast with the previous species, it shows a preference for the poorer sandy soils and is particularly common near the Pretorius Kop Gate. Trees may be seen in the Pretorius Kop and Crocodile Bridge Rest Camps and just outside the Malelane Rest Camp. It is distributed from Kenya and Angola through Rhodesia and Bechuanaland to Portuguese East Africa and the Transvaal.

The leaves are narrow, about 2 to 3 inches long and ½ to ¾ of an inch broad, wider above the middle, and are covered with fine, silky hairs. The small, whitish flowers are unpleasantly scented and are borne in slender spikes which are produced in quantity towards the ends of the branches in early summer. The flat, dry, one-seeded fruits are of similar size to those of the preceding species. They have a pinkish colour when mature which, combined with the grey foliage, makes an attractive show. The young branchlets frequently develop an oval, woody swelling, due to an insect gall.

The timber is yellow in colour, close-grained and hard, and extremely tough to work. It is also a useful wood for fuel purposes. An infusion of the root is taken by natives for stomach disorders.

FIG. 127.—*Terminalia prunioides* Lowveld Terminalia or Sterkbos, near Pafuri.



MYRTACEAE. Myrtle, Guava and Eucalyptus family.

A large and economically valuable family of over 2,000 species, occurring mainly in Australia, America and Asia, and noted for some excellent edible fruits, spices, timber and ornamental trees. From the tropics of Central and South America comes the Guava (*Psidium guajava*) and several other attractive fruits, while cloves are obtained from the dried flower-buds of the East Indian tree, *Eugenia caryophyllata*. The numerous Gum trees of the genus *Eucalyptus* are a feature of Australian vegetation and many species are planted in South Africa for their timber and for ornamental purposes.

Two species belonging to the Myrtle family are indigenous to the Kruger National Park, namely *Syzygium cordatum* and *Syzygium guineense*, known as the Water-berry and Water-pear respectively. In addition, a few Guava trees are scattered along the Sabi River, the seeds having probably been brought down by the river, and the observant visitor may see one beside the Sabi River causeway, on the south bank of the river. There is also a group of Eucalyptus trees in the Park, visible from the road between Crocodile Bridge and Kemp's Cottage, and said to mark the site of a camp of workmen engaged on building the Komatipoort-Skukuza railway.

178. Syzygium cordatum Hochst. WATER-BERRY, WATER-TREE, MUTHWA, MUHLWA (Shangaan); UMCOZI (Swazi). Fig. 128c.

The name Syzygium comes from the Greek word for *coupled*, probably referring to the manner in which the branches and leaves occur in pairs.

The Water-berry is a much-branched, leafy, evergreen tree of forest margins and stream banks, occurring from Angola and Kenya southwards to the Transvaal, Portuguese East Africa, Natal and the Transkei. In the Waterberg, it is always associated with fountains and streams but, in the moister parts of the eastern Transvaal, at medium altitudes, it grows as an isolated tree up to 30 feet high. In the Park it occurs around Pretorius Kop, where it rarely reaches tree size, and along streams towards Skukuza. A specimen may be seen in the Skukuza Rest Camp.

The leaves are in opposite pairs, are leathery in texture, oval-oblong in shape and are about 2½ to 3 inches long and 1½ to 1¾ inches broad. They are broad and cordate at the base and are stalkless or are produced on very short leaf-stalks. The young twigs are distinctly four-angled.

The white flowers are produced in sprays at the ends of the branches and resemble Eucalyptus flowers to some extent. The fruits are the size of small cherries, purplish black and edible when ripe. One, or occasionally more, large black seeds are embedded in the pulp, which has an "agreeably acid flavour".

The wood is pinkish-brown, of medium weight and fairly hard and, according to Sim, requires to be water-cured to make it durable.

179. Syzygium guineense (Willd.) DC. WATER-PEAR, MUTHWA (Shangaan). Fig. 128a and b.

This species is very similar in appearance to *S. cordatum* and the main distinction lies in the shape of the leaves. In *S. guineense* the leaves are not cordate at the base, but are wedge-shaped, i.e., they taper towards the leaf-stalk, and the leaf-stalks are longer than in *S. cordatum*. These differences are clearly seen in the accompanying diagram, Fig. 128. The two species are practically identical in flower and fruit characters.

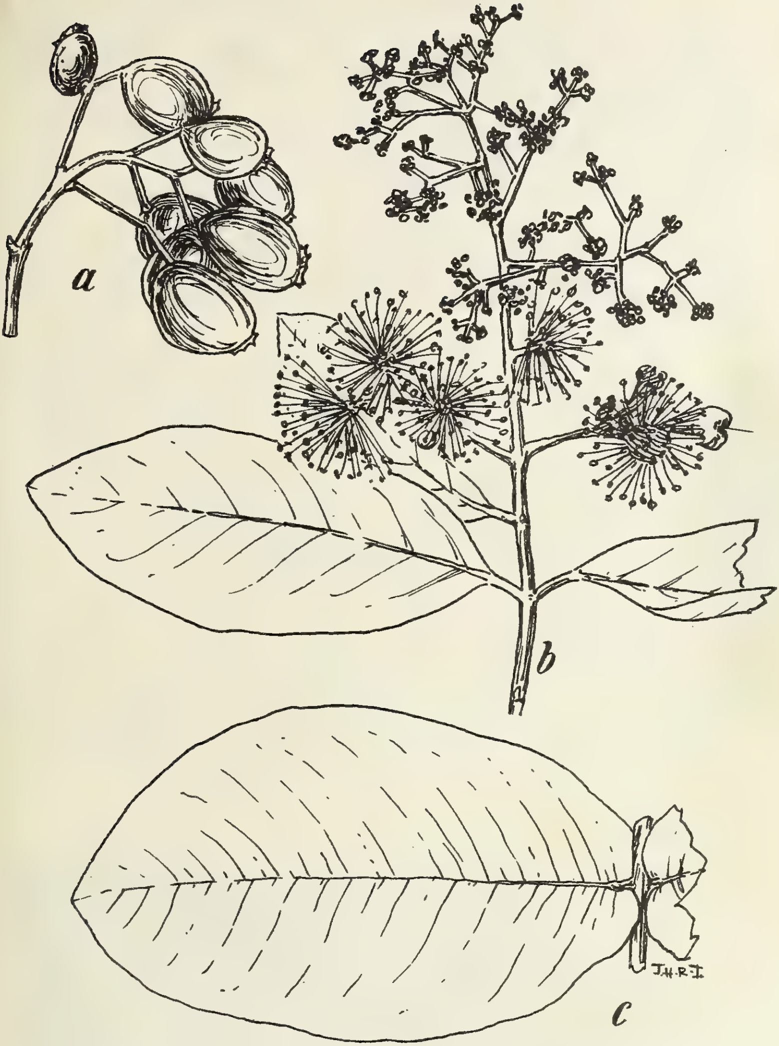


FIG. 128.—a and b, *Syzygium guineense*, Water-pear (after Cythna Letty in *Flowering Plants of Africa*); c, *Syzygium cordatum*, Water-berry.

The Water-pear is more usually associated with forest conditions and wooded stream banks and occurs in the southern part of the Park and near Punda Maria. Its distribution extends from tropical West Africa as far south as the eastern Transvaal.

ARALIACEAE. Cabbage-tree or Kiepersol family.

Only one genus of this family is found in South Africa, namely, *Cussonia* and it is represented in the Kruger National Park by two species, *C. spicata* and *C. natalensis*.

180. Cussonia spicata Thunb. CABBAGE-TREE; KIEPERSOL; MUSENJE (Shangaan); UMSENGA (Swazi). Fig. 129.

The genus is named in honour of P. Cusson, a celebrated French botanist.

This species is a small tree with a relatively stout, corky trunk, branching sparingly, with each branch terminating in a round crown of leaves or a candelabra-like inflorescence. It inhabits rocky koppies in the southern part of the Park and is recorded also from the broken country north of Punda Maria.

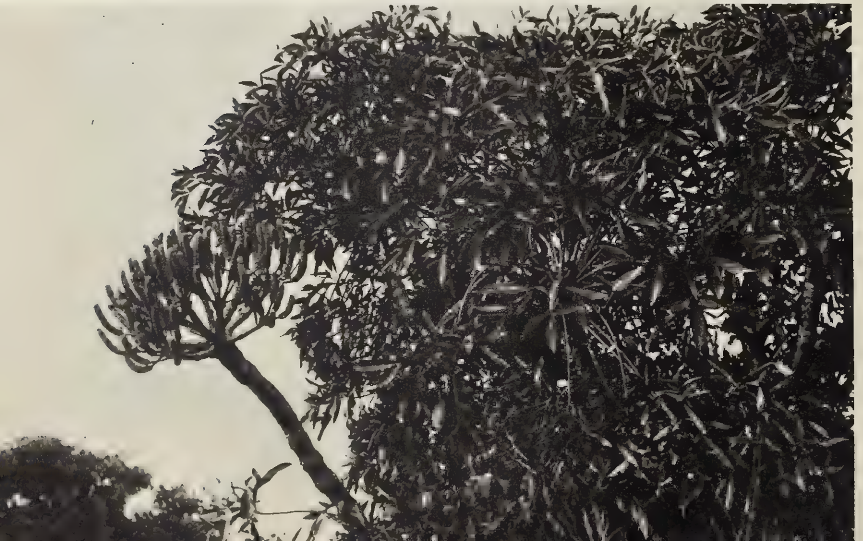
The leaves are large, bluish-green in colour and are palmately divided into a number of leaflets radiating from the end of a long leaf-stalk. The leaflets themselves are lobed and dissected, and the margins of the leaflets are irregularly toothed. The flowers are closely packed on thick spikes, which are arranged in a branched inflorescence (compound umbel), and have the appearance of a number of yellow-green candles, turning brownish black as the fruits ripen. It may be mentioned that Thunberg's original description of *C. spicata* was based on Eastern Provnice plants, which are much less robust than those here described, while the flower-spikes are smaller and are arranged in simple umbels.

The timber is soft, light and cross-grained and is suitable only for use as brake-blocks.

181. Cussonia natalensis Sond. NATAL CABBAGE-TREE.

A larger tree than the previous species, growing to 20 or 25 feet high, usually with a single, stout trunk and branching freely to form a large round crown of foliage. Its distribution is limited to Natal, the Transvaal and Southern Rhodesia and it is found on rocky hillsides in the southern part of the Park, for example on Ship Mountain and on the koppies west of Malelane.

FIG. 129.—*Cussonia spicata*, Cabbage-tree or Kiepersol, on Ship Mountain.



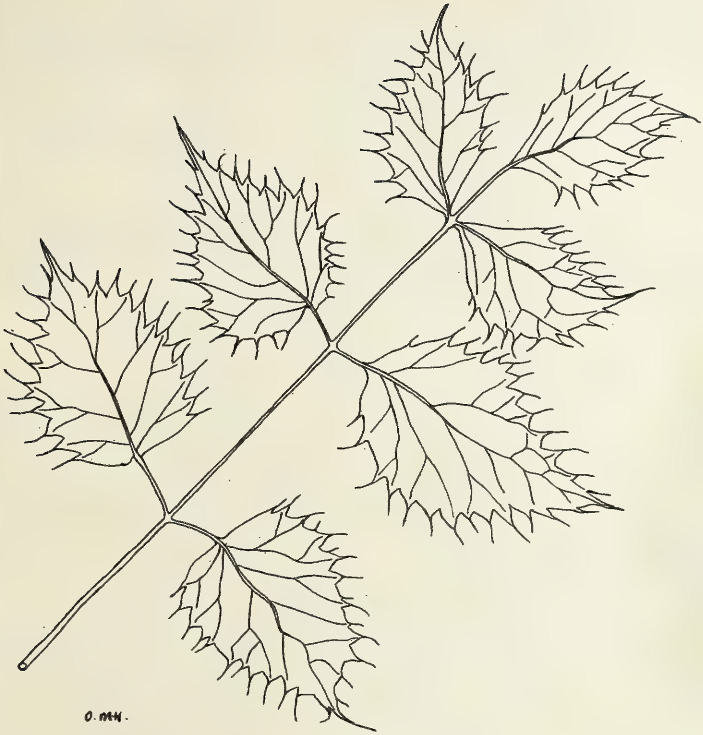


FIG. 130.—*Steganotaenia araliacea,* Transvaal Carrot-tree.

The deciduous leaves are much smaller than those of *C. spicata.* They are five-lobed, rather like a deeply divided maple leaf, and are carried on slender leaf-stalks. The flowers are arranged on a number of small, stumpy spikes, 1 to 2 inches in length, radiating from the ends of the branches.

UMBELLIFERAE. Parsley and Carrot family.

A preponderately herbaceous family which includes several useful vegetables, for example, the carrot, parsnip and celery; some aromatic herbs (aniseed, caraway, coriander, cumin, dill, etc.); and quite a number of species which are the source of drugs or poisons, for instance, asafoetida and hemlock. Some South African herbs belonging to this family are known to have medicinal properties. Two of the rare woody plants of the family are found in the Kruger National Park, namely, *Steganotaenia araliacea* and *Heteromorpha stenophylla.*

182. Steganotaenia araliacea Hochst. TRANSVAAL CARROT-TREE. Fig. 130.

A small, deciduous, sparingly branched shrub or small tree, growing to 12 or 15 feet high. The stems are soft and brittle and the older trunks are greenish in colour with papery bark peeling in strips and patches.

The light green leaves are quite unmistakable. They are pinnately compound, consisting of a long leaf-stalk with 2 or 3 pairs of large, well-spaced leaflets and a terminal leaflet. The individual leaflets are roundish and pointed, about 1¼ to 1¾ inches long, with the edges very conspicuously toothed in the Transvaal specimens .

Sprays (compound umbels) of small, whitish flowers are produced on long flower-stalks before the leaves, and are clustered at the ends of the thick, soft branchlets. They are followed by numerous dry, flattened fruits about ⅓ of an inch long and ¼ of an inch broad.

The Carrot-tree occurs on rocky ridges in the southern part of the Park, for example on Ship Mountain, and in the broken country north of Punda Maria. As well as the eastern and northern Transvaal, it is found in Portuguese East Africa, Nyasaland, Tanganyika, the Rhodesias, Bechuanaland, Angola and South West Africa.

PLUMBAGINACEAE. Plumbago family.

183. Plumbago capensis Thunb. PLUMBAGO.

This well-known garden shrub with its beautiful pale blue flowers is indigenous to southern Africa and is now cultivated practically throughout the world. In the Kruger National Park, it has been found only on rocky hillsides in the southern part of the Park, for example on Ship Mountain, where it grows as a small shrub 3 feet high in light shade.

A related species, *Plumbago zeylanica* L., is a small, straggly shrub with white flowers, which is usually found in dry, shady places and occurs in the southern part of the Park and also near Punda Maria.

SAPOTACEAE. Stamvrug and Moepel family.

The family consists mainly of tropical trees, many of which are of economic value. Perhaps the family's greatest contribution to modern life is the chickle gum, derived from the coagulated resinous latex of a Central American tree, *Achras sapota,* and which, with various added flavours, forms the basis of " chewing gum ". The milky latex of other species provides Gutta Percha and Balata, rubber-like substances of value as water-proofing and insulating materials. Other species produce a useful hard timber, while several are known for their attractive edible fruits.

Three genera, notable for their pleasant edible fruits, are found in South Africa. In the Kruger National Park, four species have been recorded, covering all three genera, but they are never common or conspicuous. They are described in the following order: *Chrysophyllum magalismontanum* (Stamvrug), *Mimusops mochisia* (Nwambu), *M. zeyheri* (Moepel) and *Sideroxylon inerme* (White Milkwood).

184. Chrysophyllum magalismontanum Sond. WILD-PLUM; STAMVRUG; NOMBELA (Shangaan).

The generic name is derived from the Greek words for *golden leaf,* in reference to the golden colour of the under surface of the leaves.

This species is a shrub or small tree, found in rocky wooded situations from northern Natal, through the Transvaal to Portuguese East Africa, Rhodesia and Bechuanaland. In the Kruger National Park it is rare, a few plants being found in the Pretorius Kop and Punda Maria sections.

It is always a conspicuous plant, with its evergreen leaves, dark green and glossy on the upper surfaces and rusty-felted below, oblong in shape, 2½ to 3 inches long and about 1 inch broad. The small flowers, on short flower-stalks, are produced in large numbers on the old wood, with the result that the fruits become clustered along the branchlets,

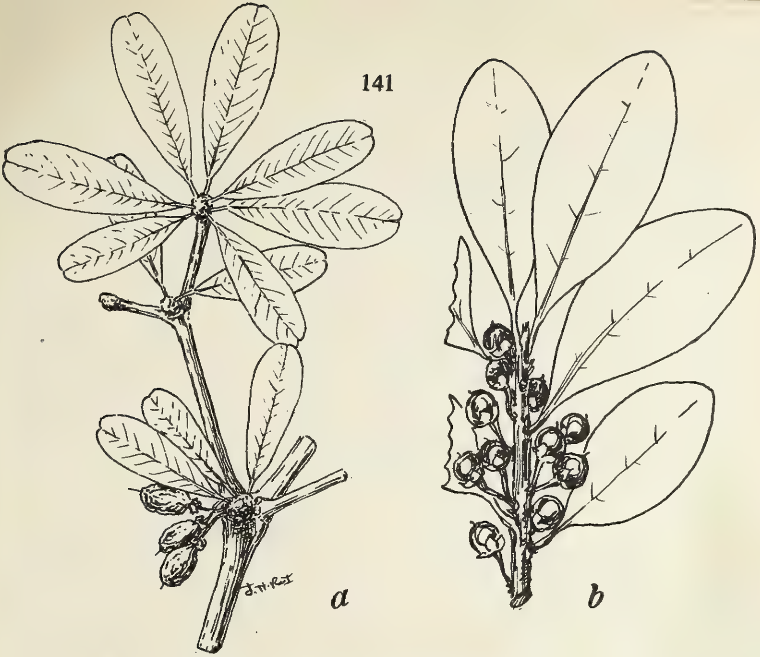


FIG. 131.—a, *Mimusops mochisia*, Nwambu: fruiting branch, × ¾; b, *Sideroxylon inerme*, White Milkwood: fruiting branch, × ¾.

giving rise to the popular name Stamvrug (stem-fruits). When ripe, the fruits are ovoid in shape, like small plums, and are bright scarlet in colour, consisting of 1 or 2 stones surrounded by a sweet-acid pulp containing a sticky, milky juice. The pulp is pleasant to the palate when fully ripe and makes excellent jam, resembling plum jam in appearance and flavour.

185. Mimusops mochisia Bak. UMNGWAMBU (Swazi); N'WAMBU (Shangaan). Fig. 131a.

Mimusops is derived from the Greek for *ape-like*, but the application is not obvious.

The Nwambu is a deciduous, much branched shrub or small tree up to 15 feet high. It is scattered throughout the Park, but is never very common. In the south, around Skukuza, it is strongly associated with the thorn and Tambootie scrub on grey, brackish, sandy flats. It is found also in Swaziland, Portuguese East Africa, Rhodesia, Bechuanaland and Nyasaland.

The leaves, which are roughly veined and hard textured, are about 1 to 1½ inches long and ½ an inch broad, broader above the middle and rounded at the apex. They are smooth and are produced in tufts on the small, abbreviated, twiggy branches. Clusters of small, yellowish flowers, each on a short flower-stalk, appear at the ends of these branchlets in early spring before the leaves. The fruit is like a small olive, about ½ an inch long, tipped with a short bristle. It consists of a large seed with a thin fleshy covering which has a pleasant taste and is regarded by the natives as one of the most attractive wild fruits.

Some authorities separate the genus *Manilkara* from *Mimusops* and, if these authorities are followed, this species will become *Manilkara mochisia*.

186. Mimusops zeyheri Sond. MOEPEL; UMPHUSHANE (Swazi).

A spreading, leafy, evergreen tree, growing up to 30 feet high, occurring from the Magaliesberg to Rhodesia. It is also found in the eastern Transvaal lowveld in wooded kloofs and has been recorded in the Pretorius Kop area, where it is usually a low shrub of less than 10 feet high.

The leaves are glossy green, narrowly oval to lance-shaped, about 2 to 3 inches long and 1 inch broad, on slender leaf stalks about 1 inch long. The young twigs and under surfaces of young leaves, especially on the veins, are covered with rusty coloured short hairs.

The small flowers are whitish and are borne on short flower stalks in the axils of the leaves, towards the ends of the young branches. The fleshy fruits are about ¾ to 1 inch long and are tipped with a short bristle. They are yellow when ripe and contain 1 to 4 large seeds. The fleshy pulp is " somewhat mealy and pleasantly sweet-flavoured ", but the lowveld natives regard it with less favour than the preceding species.

187. Sideroxylon inerme L. WHITE MILKWOOD. Fig. 131b.

The generic name is derived from the Greek *sideros*, iron, and *xylon*, wood, in allusion to the hardness of the wood.

The White Milkwood is a forest tree of western and eastern Cape Province, Natal, Swaziland and the Transvaal, extending to the open bush country in the lowveld and along the coast. It occurs also in Portuguese East Africa and Nyasaland. In open bush situations, it develops a shrubby growth form, branching freely from ground level and rarely exceeding 12 to 15 feet in height.

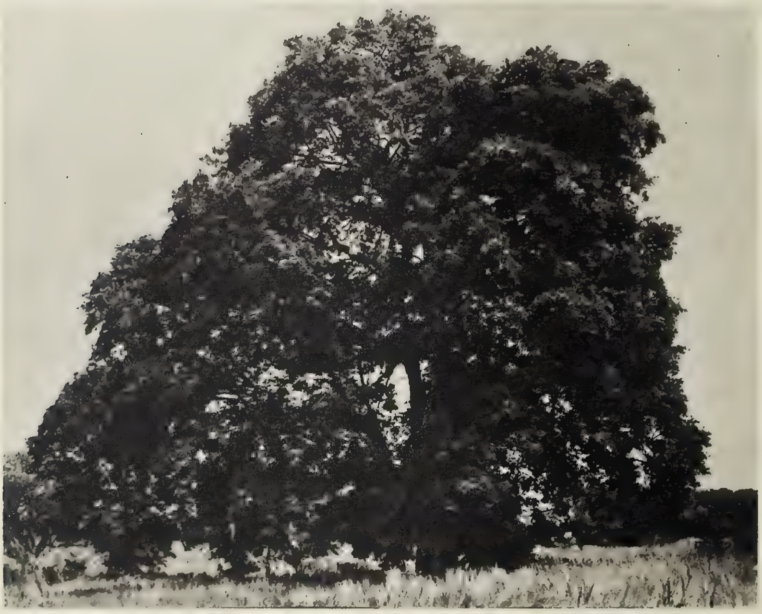


FIG. 132.—*Diospyros mespiliformis*, Transvaal Ebony or Jakkalsbessie, between Pretorius Kop and Skukuza.

It is this growth form that is found in the Kruger National Park, where it occurs in the Pretorius Kop section.

The leaves are leathery in texture and are glossy green, long-oval to lance-shaped, about 3 to 4 inches long and 1¼ inches broad, on short leaf stalks. Small whitish flowers with an unpleasant odour are produced on short flower-stalks in the axils of the leaves towards the ends of the young branches. The fruits are globose, black when ripe and are about ½ an inch in diameter, tipped by the persistent style which forms a short bristle, as in the preceding three species. The juicy flesh contains a milky sap and is edible though said to be less pleasantly flavoured than the Nwambu (*Mimusops mochisia*).

The timber is reported by Sim to be heavy, hard and durable and suitable for fencing posts, boat building etc. Watt and Brandwijk state that an infusion of the bark is taken by the Zulus to dispel bad dreams.

EBENACEAE. Persimmon and Ebony family.

By far the most important genus of this family is *Diospyros*, which includes several tropical species yielding the heavy, black wood known as ebony, while quite a number have edible fruits. Of these, the best known is the Persimmon (*D. virginiana*) of America. The solitary species occurring in South Africa, and found in the Kruger National Park, is *D. mespiliformis*, which yields a useful timber and also bears fruits that are edible. Other genera represented in the Park are *Euclea* and *Royena*.

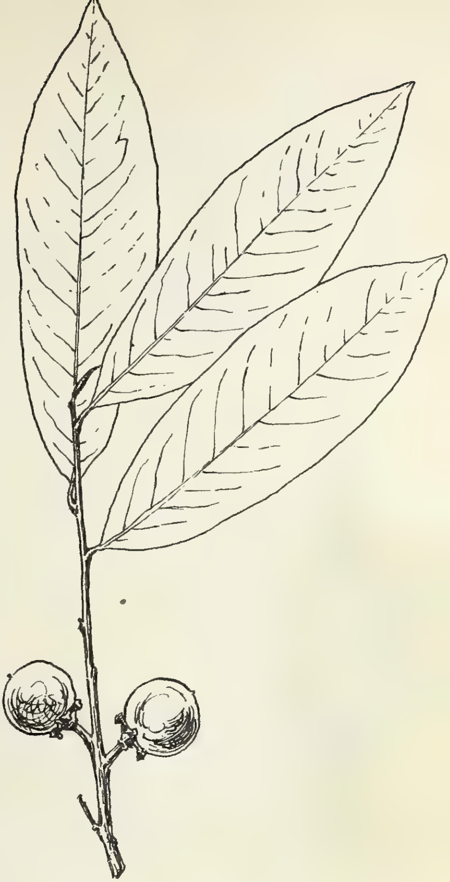


FIG. 133.—*Diospyros mespiliformis*, Transvaal Ebony or Jakkalsbessie: fruiting twig, × ¾.

188. Diospyros mespiliformis Hochst. TRANSVAAL EBONY; JAKKALSBESSIE; UMTOMA (Swazi); NTOMA (Shangaan). Figs. 132 and 133.

The name of the genus is of Greek origin and may be translated as *divine pear*, in reference to the edible fruits of some species.

The Transvaal Ebony or Jakkalsbessie is a large, practically evergreen tree with dark green foliage, growing up to 40 or 50 feet high, though more usually of smaller stature. It is wide-spread in east and west tropical Africa and extends southwards to the eastern Transvaal lowveld, where it is scattered throughout the Kruger National Park. It is common along rivers and in the open woodland around Pretorius Kop, often showing a preference for growing on termite mounds. Trees may be seen in the Pretorius Kop, Malelane, Punda Maria and Pafuri Rest Camps.

The leaves are long and narrow, averaging 4 to 5 inches long and about 1 inch wide, somewhat resembling peach-tree leaves in shape. They turn yellow for a short time in early spring before being shed and the young leaves are brightly tinted with red, producing an ornamental effect. Flowers are small, whitish and velvety-hairy, arising in the axils of the leaves, the male and female flowers being borne on different trees. Female flowers are solitary on short stalks, while the male flowers are in small, branched inflorescences. The fruits are tough-skinned, about the size of a cherry, consisting of several seeds surrounded by a juicy, edible pulp. The fruit is characterised by the persistent calyx at the base, resembling a shallow acorn-cup.

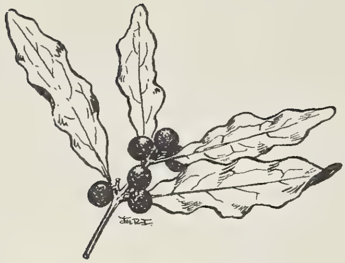


FIG. 134.—*Euclea divinorum*, Gwarri: fruiting twig, × ¾.

The timber has a light sap-wood and a very dark, heavy heart-wood, resembling ebony.

189. **Euclea divinorum** Hiern. GWARRI; NHLANGULA (Shangaan). Fig. 134.

A much branched, practically evergreen shrub, common throughout the Park, especially associated with thorn-scrub on low lying places. It occurs in scrub country in the Cape Province, Natal and Transvaal and is recorded also from Portuguese East Africa and Nyasaland.

The leaves are smooth and long elliptical, about 1½ to 2½ inches long and ½ to ¾ of an inch wide, with noticeably wavy margins. Flowers are small and are produced in clusters at the ends of the branches. They are followed by small fruits the size of a small pea, black in colour, consisting of a single seed surrounded by a fleshy covering. Although eaten to some extent, the fruits are not very palatable.

190. **Euclea multiflora** Hiern. UMCHITHAMUZI (Swazi).

A shrub growing to 8 or 10 feet high, scattered throughout the Park, but never common. It is widespread in South Africa and is found also in Bechuanaland, Rhodesia and tropical east Africa. The leaves are narrowly elliptical, about 1½ to 2½ inches long and ¾ of an inch wide. The twigs and young leaves are usually covered with a rusty pubescence. The fruits are globose, about ⅓ of an inch in diameter, and are one-seeded with a thin, fleshy covering.

191. **Royena guerkii** O.Ktze.

A low shrub 3 to 6 feet high which occurs in the Natal and Transvaal bushveld, but is rare in the Park, having been found occasionally along the Sabi River near Skukuza. The leaves are elliptical, often broader above the middle and rounded at the apex, 1 to 2 inches long and ½ to ¾ of an inch broad, and roughly veined on the under-surface. The fruits are globose, about ¾ of an inch in diameter, consisting of 3 or 4 seeds with a yellowish, pulpy covering, enclosed in a thin skin which turns bright red as the fruits ripen.

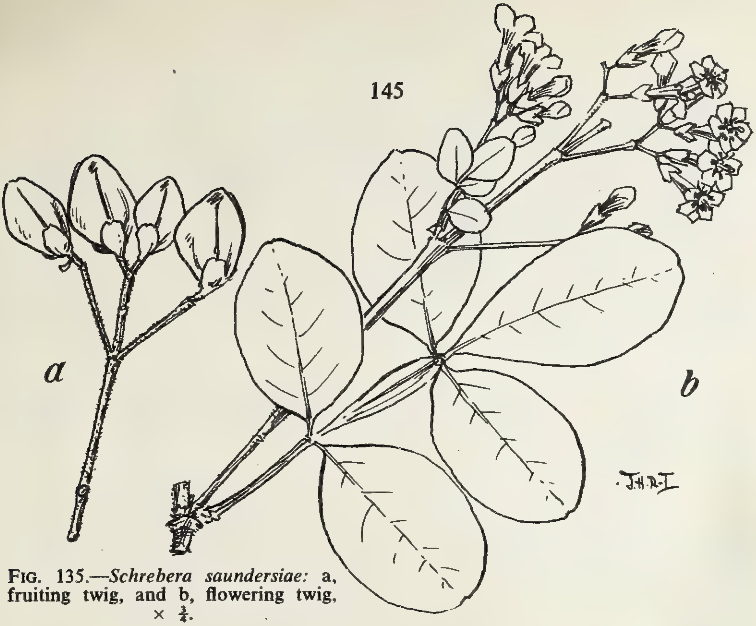


FIG. 135.—*Schrebera saundersiae:* a, fruiting twig, and b, flowering twig, × ¾.

OLEACEAE. Olive and Ash family.

A world-wide family which includes the cultivated Olive and valuable timber and ornamental trees, such as the Ash of Europe and America and the Black Ironwood (*Olea laurifolia*) of South Africa. Genera found in the Kruger National Park are *Olea, Schrebera* and *Jasminum*, but they play a minor part in the vegetation of the Park.

192. Olea africana Mill. WILD OLIVE. (=*O. verrucosa* Link.)

Olea is the classical Latin name for the olive.

The South African Wild Olive is a shrub or small tree up to 20 feet high, which is wide spread in the drier bush country of South Africa, especially in areas where the soil is rich in lime. It is rare in the Kruger National Park and is found as a shrub 6 to 8 feet tall, associated with other taller species on wooded hillsides and stream banks.

The leaves are evergreen, long and narrow, resembling the cultivated olive of Europe, the main difference being in the size of the fruit, which is very small in *O. africana*. The cultivated olive has been successfully grafted on the wild South African species.

An infusion of Wild Olive leaves is used by the natives and Europeans as an eye lotion.

193. Schrebera saundersiae Harv. sEHLULAMANYE (Swazi). Fig. 135.

A shrub or small tree, confined to the eastern Transvaal lowveld, and occurring somewhat rarely around Pretorius Kop in the Kruger National Park. It is a deciduous species, producing clusters of small, attractive, white and mauve flowers with a jasmine scent, at the ends of the branches in early summer. The leaves are pinnately compound, consisting of one or two pairs of large leaflets and a terminal leaflet, with a distinct "wing" along the midrib. The fruits are dry capsules which split in halves longitudinally, releasing a number of winged seeds.

The root is used by the natives for success in war and hunting and this is implied in the Swazi name.

194. Jasminum mauritianum Boj. WILD JASMINE.

A many-stemmed shrub or woody climber which occurs in the southern part of the Park. The leaves are trifoliolate, smooth or slightly hairy. Clusters of white, star-like flowers appear in September or October, filling the air with their characteristic heavy, sweet perfume.

195. Jasminum stenolobum Rolfe. WILD JASMINE.

This is also a woody climber, occurring in the extreme north of the Park, near Punda Maria. The leaves are simple, greyish in colour and softly pubescent, while the flowers are white and sweetly scented as in the previous species.

SALVADORACEAE. Mustard-tree family.

A small family represented in South Africa by two species, both of which occur in the Kruger National Park, namely, *Salvadora australis* and *Azima tetracantha*.

196. Salvadora australis Schweick. TRANSVAAL MUSTARD-TREE.

A much-branched, evergreen, leafy shrub up to 10 feet high with narrow, grey, thick textured leaves about 2 inches long and ¼ to ½ an inch broad. It is found on silty flats beside the larger rivers in the northern part of the Kruger National Park and extends to Portuguese East Africa and the northern Transvaal, north of the Zoutpansberg Range.

Sprays of small, greenish flowers are produced at the ends of the branches and these are followed by small fruits, the size of a small pea, consisting of a single seed with a thin fleshy covering.

An allied species, *Salvadora persica*, is distributed throughout the orient and Africa, occurring as far south as Portuguese East Africa and South West Africa, but it appears to be absent from the Union. It has larger leaves than those of *S. australis* and the fruit is described as edible, with a sweetish, pungent taste. This species is thought to have been the " mustard " referred to in the Bible.

197. Azima tetracantha Lam. BEEHANGER; RIBABA (Shangaan).

A spiny shrub, sometimes scrambling in bushes and small trees up to a height of 8 or 10 feet. It occurs throughout tropical Africa, extending from Somaliland to the Transvaal, Natal and eastern Cape Province. In the Kruger National Park it is usually associated with thorn scrub on brackish or silty flats, for example, near Skukuza and along the Levubu River.

The stems are slender, dark green in colour and are sometimes four-angled. The spines are also slender and green, about ½ to 1¼ inches long, and usually arise in opposite pairs, so that four spines normally radiate from each node. The leaves are smooth and leathery in texture, oblong or ovate in shape, about ¾ to 1¼ inches long, and usually end in a sharp point. The popular name for the species is possibly derived from the butcher-birds' habit of impaling insects on spines.

LOGANIACEAE. Strychnos family.

Three genera belonging to this family are found in the Kruger National Park. *Strychnos*, with six species, is the most important, the other two being represented by one species each, namely, *Anthocleista zambesiaca* and *Lachnopylis oppositifolia*.

198. Anthocleista zambesiaca Bkr. FOREST FEVER-TREE; GALUDZU (Shangaan).

The generic name is derived from the Greek *anthos*, a flower, and *cleistos*, closed, though the allusion is not clear.

This tree is referred to as the Cabbage-tree or Fever-tree, both names being more widely used for other species. It is a tropical tree of wooded kloofs and stream banks, extending to the foothills of the Drakensberg in the eastern Transvaal, and is recorded in the extreme north of the Park, near Punda Maria.

The leaves are exceptionally large, more or less oblong in shape, as much as 2 or 3 feet long and up to 12 or 15 inches wide, broadening above the middle. The largest leaves are found on young saplings and a crown of these enormous leaves at the top of a slender young stem is a striking sight in forest undergrowth. Older trees are freely branched, up to 40 or 50 feet in height, with leaves only 1½ to 2 feet long.

The flowers are produced in large, branched inflorescences at the ends of the brittle branches. Each flower consists of a tubular portion about an inch long with a number of spreading, waxy-white lobes. The wood is soft and brittle and is of no value.

199. Lachnopylis oppositifolia Hochst.

A slender shrub scattered along river banks throughout the Park, growing to a height of 6 or 8 feet. The leaves resemble willow leaves and are about 2 to 3 inches long and less than ½ an inch broad with widely toothed margins. The flowers are small and are produced in bunches at the ends of the branches.

Strychnos.

This is undoubtedly the most important genus of the family with about 200 species, found in the tropics and, occasionally, sub-tropics of the Old and New Worlds. The seeds of some species contain certain highly poisonous substances, for example, those of *S. nux-vomica,* a native

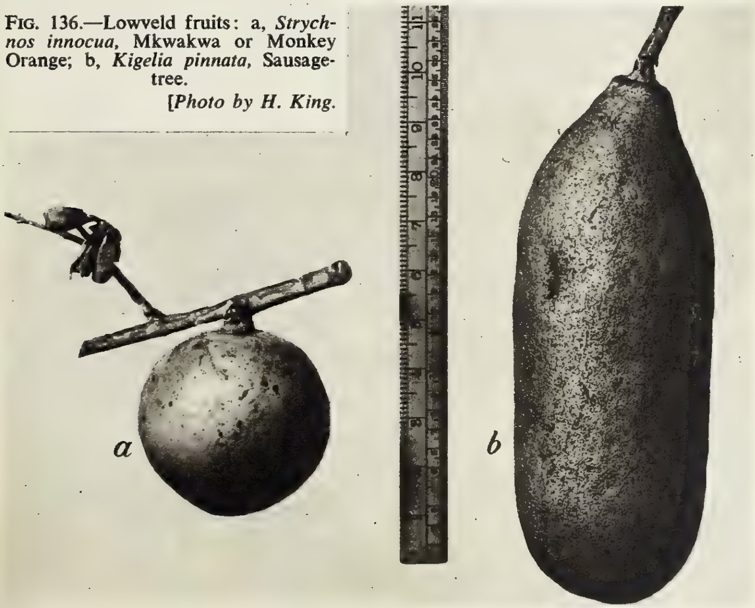


FIG. 136.—Lowveld fruits: a, *Strychnos innocua,* Mkwakwa or Monkey Orange; b, *Kigelia pinnata,* Sausage-tree.

[*Photo by H. King.*

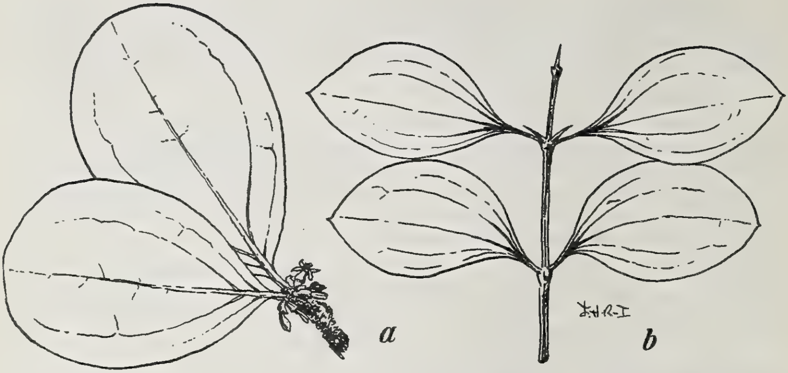


FIG. 137.—a, *Strychnos innocua,* Mkwakwa or Monkey Orange: flowering twig, × ¾; b, *Strychnos spinosa,* Msala or Monkey Orange, × ¾.

of tropical Asia, are the source of strychnine. On the other hand, the curare poison used by the South American Indians to poison their arrows is extracted from the bark of another species, *S. toxifera.*

The six species found in the Kruger National Park may be classified into two groups, according to the size of the fruits. Firstly, there is a group of large fruited species in which the fruit is a hard shelled sphere resembling an orange and containing a number of large seeds embedded in an edible pulp. The species in this group are: *Strychnos innocua* (Mkwakwa) and *S. spinosa* (Msala), and they are usually found as small trees inhabiting open bush country.

Secondly, there is a group with small spherical or ovoid fruits ½ to ¾ of an inch in diameter, with one (or rarely two) seeds surrounded by a soft, pulpy tissue, the whole contained in a thin, leathery skin. The four species in this group, *S. henningsii, S. decussata, S. micans* and *S. stuhlmannii,* appear to prefer densely wooded hillsides and kloofs.

200. Strychnos innocua Del. MONKEY-ORANGE; KLAPPER; MKWAKWA; NKWAKWA (Shangaan). Figs. 136a and 137a.

A deciduous, small tree up to 25 feet high which occurs from the Nile Land and tropical Africa southwards to Portuguese East Africa, the Transvaal lowveld and northern Zululand. It is common in the southern part of the Kruger National Park, especially in open bush country around Pretorius Kop, and specimens may be seen in the Pretorius Kop and Malelane Rest Camps.

The leaves are produced in opposite pairs and are elliptic in shape and rounded at the apex, about 1½ to 2½ inches long and ¾ to 1 inch broad. They are leathery in texture and are softly hairy, especially in the young stage. The small, yellow-green flowers are produced in clusters close to the stems before the young leaves appear in spring. The fruit is a hard-shelled sphere up to 3½ inches in diameter, green at first and becoming yellowish to light brown when mature, enclosing a number of large, roundish to oval seeds embedded in cream-coloured pulp. When ripe, the pulp has a sweetish flavour and, if scraped off the kernels and dried, it lasts for months as a food reserve. The kernels have a high oil content but also contain a bitter principle and are, therefore, discarded by natives.

201. Strychnos spinosa Lam. MONKEY ORANGE, MSALA; KLAPPER; NSALA (Shangaan); UMSALA (Swazi). Figs. 137b and 138.

Like the previous species, this is a deciduous shrub or small tree growing up to 20 feet in height. It is also a tropical east African species, extending southwards to the Transvaal lowveld, Portuguese East Africa and northern Zululand. It occurs with the Mkwakwa around Pretorius Kop, but is scattered throughout the Park and a small tree may be seen in the Letaba Rest Camp, near the office, and in Skukuza Rest Camp.

This species shows a good deal of variation and requires further study. The leaves are opposite, like all *Strychnos* species, and are oval in shape, up to 2½ inches long and 1½ inches broad, but often much smaller. They are soft textured and usually smooth. The young twigs often end in a distinct spine and occasionally bear short, hard spines (reduced branches) at the nodes. The flowers are small as before, but are produced in clusters at the ends of the young branchlets in spring. The fruit is also similar, possibly larger, up to 4 inches in diameter, and light brown when mature. The pulp surrounding the large seeds is also edible, though natives aver that it must be eaten fresh as it cannot be stored like the Mkwakwa.

The bark of both species is greyish in colour and slightly roughened but not corky, while the wood is white and coarse grained and is not put to any use.

The Msala is easily confused with the closely related species, *S. cocculoides* Bak. (= *S. schumanniana* Gilg), which appears to be absent from the Kruger National Park, but which is common in parts of the Waterberg, where it is known as the Suurklapper. The branchlets of *S. cocculoides* show the same spiny character as those of *S. spinosa,* but the leaves and young twigs appear to be invariably hairy (pubescent).

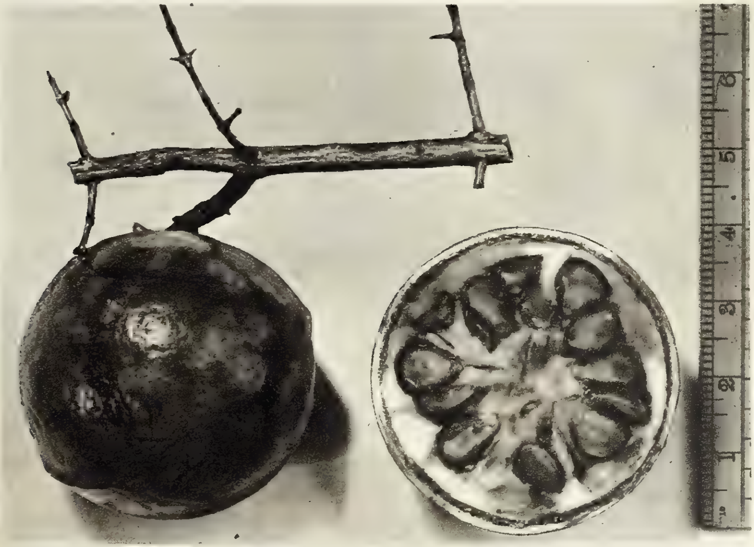


FIG. 138.—*Strychnos spinosa,* Msala or Monkey Orange.
[*Photo by H. King.*

The two species may be distinguished in the field by the more erect crown and thick, corky bark of *S. cocculoides,* while *S. spinosa* has a more open spreading crown and seems never to develop a corky bark.

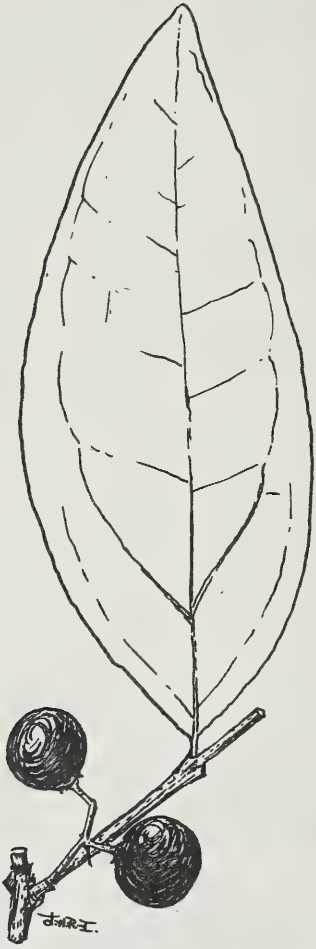


FIG. 139.—*Strychnos stuhlmannii:* fruiting twig.

202. Strychnos stuhlmannii Gilg. NTSUPA (Shangaan). Fig. 139.

This species is known from Tanganyika, Portuguese East Africa and Bechuanaland and has only recently been found within the borders of the Union in the Punda Maria section of the Kruger National Park. The tree is present in the Rest Camp grounds and others occur along the Levubu River, usually in rocky, well wooded situations.

It is a deciduous tree up to 35 feet high. The mature leaves are large and soft textured, broadly lance-shaped or oblong, 5 to 7 inches long and up to 2½ inches broad, tapering to the apex. The fruits are single-seeded berries about ½ an inch in diameter, black in colour when ripe. They are crushed by the natives and thrown into the water to kill fish.

203. Strychnos henningsii Gilg. HARD-PEAR.

This is a tree which inhabits densely wooded hillsides and kloofs in the Malelane area and is found also in forests in Natal and the eastern Cape Province. The leaves are elliptical, about 1½ to 2 inches long, smooth and firm in texture. The single-seeded fruits are about ¾ of an inch in diameter and are known to contain a poisonous alkaloid with an action similar to strychnine.

204. Strychnos decussata (Pappe) Verdoorn.

205. Strychnos micans S. Moore.

These are two related species with small fruits, very similar in appearance to *S. henningsii.* Both have been collected on dry, bush-covered hillsides in the Punda Maria area, but they are never conspicuous or important.

APOCYNACEAE. Amatungula family.

A large family of over 1,000 species, dispersed mainly in the tropics of both hemispheres and made up largely of trees, shrubs and woody climbers. Many of them have milky latex which is exploited in some species as a source of rubber, for example, the African and Madagascar rubber, derived from certain species of *Landolphia*. In others the sap is poisonous, for example, the Hottentot's Poison-bush (*Acokanthera venenata*) and the Oleander (*Nerium oleander*), while the seeds of some *Strophanthus* species contain a highly toxic substance, strophanthine. Many of the trees and shrubs have ornamental flowers as, for instance, *Allamanda, Nerium oleander* and *Plumeria* (Frangipani).

Representatives of the genera *Acokanthera, Adenium, Pachypodium, Carissa, Conopharyngia, Diplorrhynchus, Holarrhena, Landolphia, Rauvolfia, Strophanthus* and *Wrightia* are found in the Kruger National Park, but are never plentiful or important constituents of the vegetation.

206. Acokanthera sp.

A shrub closely related to the Hottentot's Poison Bush (*A. venenata*), but not yet named, has recently been found on exposed sandstone ridges near Punda Maria. It is densely branched and evergreen, growing up to 6 feet high. The leaves are oval, 1½ to 2 inches long and 1 to 1½ inches broad, leathery in texture like other species of *Acokanthera*, but with a rough, sand-papery surface as distinct from the smooth leaves of *A. venenata*.

Flowers are produced in clusters in the leaf axils and are white in colour with a pinkish tinge. Each flower has a corolla tube about ½ an inch long, with five small lobes. The fruits are ovoid, about ½ an inch long consisting of a large seed with a thin fleshy covering. The fruits and sap of *A. venenata* are known to be poisonous and similar qualities are probably possessed by this closely related species.

207. Adenium multiflorum Kl. IMPALA LILY. Plate V (page 130); Fig. 142.

The genus is said to be named after Aden, the native place of some species.

The Impala Lily occurs in Nyasaland, Portuguese East Africa and the Transvaal and is scattered throughout the Park. It is cultivated in several rest camps for its beautiful pink and white flowers which appear in the heart of winter. It is a succulent-stemmed shrub with a few branches arising from a thickened, underground tuber. When protected from browsing animals, it grows to 3 to 4 feet high, but plants outside the rest camps are usually browsed by the smaller antelopes to within a few inches of the ground.

The leaves are large, elliptical and semi-succulent, about 3 to 4 inches long, and are shed during winter. The showy flowers appear soon afterwards at the ends of the stumpy, practically leafless branches and consist of a whitish tube about 1½ inches long and five spreading lobes with wavy margins edged with bright rose-pink.

208. Adenium swazicum Stapf. SUMMER-FLOWERING IMPALA LILY.

In contrast to the previous species, *A. swazicum* flowers in summer while the plants are still in leaf. The flowers are larger than those of the Impala Lily, with a longer and more open tube, and are uniformly coloured in shades of deep pink to reddish purple.

This species is found in the southern part of the Park, especially around Malelane, and extends to Swaziland and Portuguese East Africa.

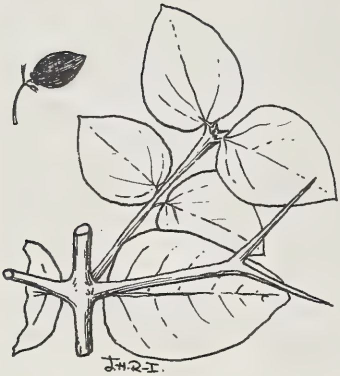


Fig. 140.—*Carissa bispinosa,* Num-num, showing leaves and fruit.

The succulent stems grow about 12 or 18 inches high from an enlarged, underground tuber, and the leaves are large and elliptical, like those of the Impala Lily.

Both species of Adenium are sensitive to frost and do not thrive away from the lowveld. They do not transplant easily and the best method of propagating them is by means of seed.

209. Carissa bispinosa (L.) Desf. NUM-NUM. Fig. 140.

A spiny shrub, rarely more than 4 or 5 feet tall, which is related to the Amatungula (*C. grandiflora*). It is found in bush groups around Pretorius Kop and is recorded from Nyasaland, Rhodesia, the Transvaal, Natal and the Cape Province. The leaves are opposite and are broadly ovate, tapering to a point and the branches bear opposite, strong, forked spines. The young stems, spines and leaves are dark green in colour. Small white flowers are produced at the ends of the branchlets and are followed by small, oblong fruits about ¼ of an inch long. They are red when ripe and pleasant to eat, containing a milky pulp surrounding one or two seeds.

Two other species have been found in the Kruger National Park, namely, *Carissa edulis* Vahl from the Punda Maria area and *Carissa tetramera* Stapf from rocky hillsides near Malelane, but both species are very rare.

210. Conopharyngia elegans Stapf. KAHLWANE (Shangaan). Fig. 141a.

The generic name is derived from the Greek *konos,* a cone, and *pharynx,* the throat, in reference to the way the stamens are grouped in the throat of the corolla tube.

This species is a deciduous small tree of tropical east Africa extending to Portuguese East Africa and the Transvaal lowveld. It is found in the northern part of the Park, where it grows on wooded hillsides and river banks. A small specimen may be seen near the entrance to Punda Maria Rest Camp while, along the Levubu River, for example at the Pafuri Rest Camp, it reaches its maximum height of 20 feet.

The leaves are large and oblong, about 5 or 6 inches long and up to 2 inches broad, glossy green and smooth. The stems contain a milky latex. The white, waxy flowers appear in clusters at the ends of the branches in early summer and are followed by the quaint fruits. These consist of a pair of hard, globose, woody structures, conspicuously marked with small, raised dots of lighter colour.

Double fruits of various shapes are a feature of several other members of this family, among which are the genera *Diplorrhynchus, Holarrhena, Strophanthus* and *Wrightia.*

211. Diplorrhynchus mossambicensis Benth. TSOWA (Shangaan). Fig. 141b and c.

The name of the genus is derived from the Greek *diploos,* double, and *rhynchos,* a beak, alluding to the double fruit.

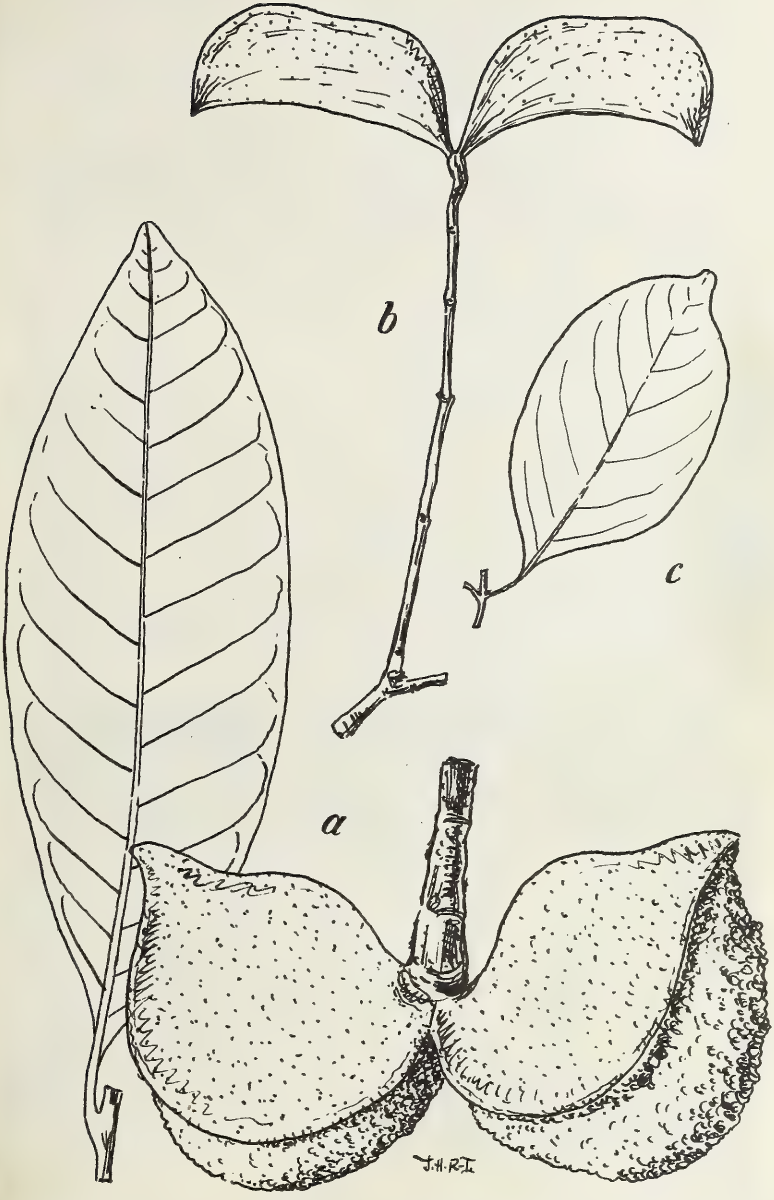


FIG. 141.—a, *Conopharyngia elegans*, Kahlwane: leaf and fruit; b and c, *Diplorrhynchus mossambicensis*, Tsowa: fruit and leaf.

This species is a graceful, small, deciduous tree or shrub which, in the Kruger National Park, is found only in the Punda Maria area on sandy flats and rocky hillsides as, for instance, in the Punda Maria Rest Camp. It shows a distinct preference for such situations and is common on the quartzite formation of the Waterberg Range. It is also found in Portuguese East Africa, Southern Rhodesia, Bechuanaland and tropical east and west Africa.

It grows to 12 or 15 feet in height with attractive, pendulous leaves which are oval, about 1½ inches long and 1 inch broad, and are completely smooth. The small flowers have a narrow, tubular corolla with five small lobes and are either whitish or pale yellow in colour, appearing in sprays at the ends of the branches in early summer. The double fruit consists of two hard, flattened, oblong capsules, which are dark brown or black when mature.

The wood is light in colour and close-grained, but stems of timber size are rarely encountered.

212. Holarrhena febrifuga Kl. SHIKAHLA-KAHLWANE (Shangaan). Fig. 143.

The generic name refers to the structure of the stamens and means " entire anthers ".

This species is a deciduous shrub or small tree up to 10 feet high distributed from tropical east Africa into the north-eastern corner of the Transvaal. It is very common over a restricted area in the Punda Maria section, showing a preference for low quartzite ridges and sandy slopes.

The leaves are large and elliptical, 4 to 5 inches long, resembling those of *Conopharyngia elegans*, and it is apparent from the Shangaan names for the two species that these natives recognise the relationship. The waxy, white flowers are also similar in shape and have a heavy perfume. The fruits are, however, entirely different consisting, in *Holarrhena*, of pairs of long, narrow, drooping pods, containing numerous small, flattened seeds.

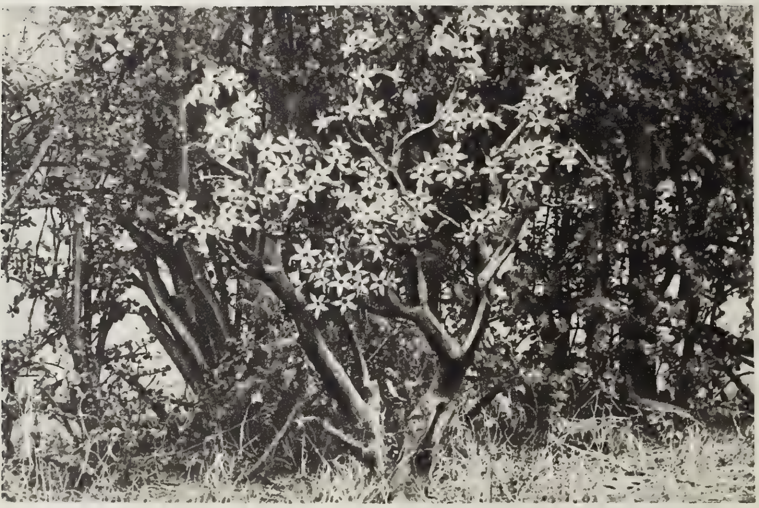


FIG. 142.—*Adenium multiflorum*, Impala Lily, in front of a hedge of Spekboom (*Portulacaria afra*), in Malelane Rest Camp. (See page 28.)

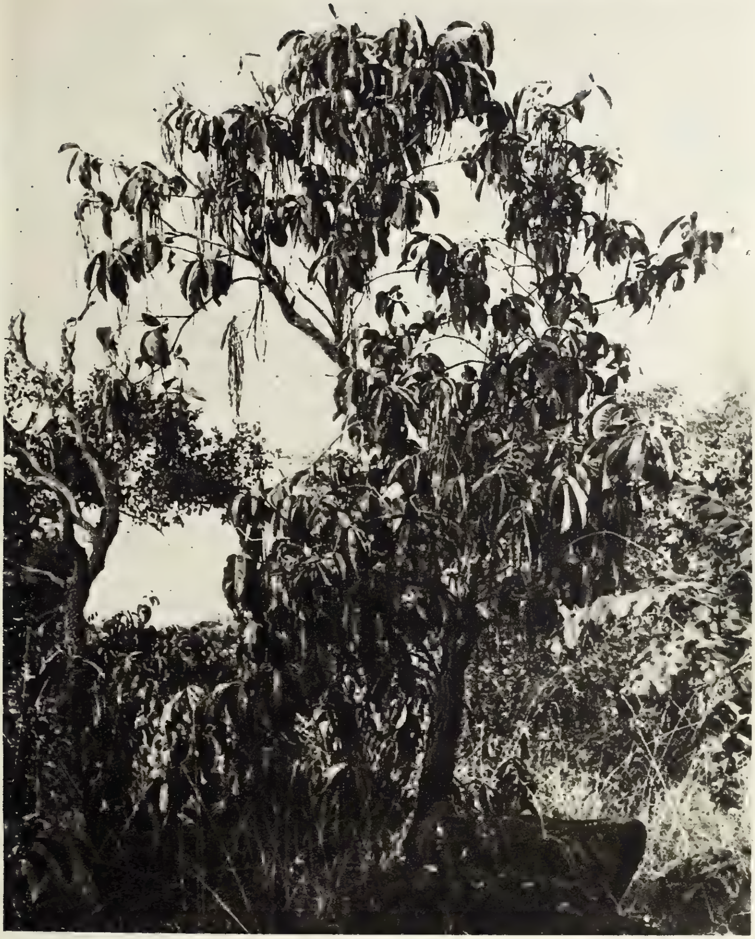


FIG. 143.—*Holarrhena febrifuga,* near Punda Maria.

213. Landolphia kirkii Dyer.

214. Landolphia monteiroi Dyer.

These two species occur on rocky, wooded hillsides in the northern part of the Park, where they grow as shrubs or climbers with slender, twining branches. In early summer, usually when the branches are still leafless, clusters of starry, white flowers are produced with a sweet jasmine scent. The fruits are spherical and about 2 inches in diameter. *L. monteiroi* is also capable of growing as a vigorous liane and the latex is exploited as a small source of wild rubber.

215. Pachypodium saundersii N.E.Br. SIKUMBYAMBYA (Swazi).

This plant is closely related to *Adenium,* but the branchlets are armed with numerous slender spines about an inch in length. It inhabits bare, rocky ridges in the Pretorius Kop and Malelane sections and often develops a swollen stem above ground a foot or more in thickness at its base. The succulent stems grow to 3 or 4 feet in height. Clusters of large white flowers tinged with purple, appear at the ends of the branches in May or June, making a very attractive show.

216. Rauvolfia caffra Sond. QUININE-TREE; NCHONGO (Shangaan). Fig. 144. (Also spelt *Rauwolfia,* but this is incorrect.)

The genus name commemorates Leonhart Rauwolf, a physician of Augsburg in the sixteenth century.

The Quinine-tree is a practically evergreen tree, growing up to 40 feet high, which occurs along streams in the Transvaal lowveld, Natal and Eastern Cape and is recorded also from Kenya, Tanganyika and Nyasaland. It is rare in the Park, having been recorded in the wild state in a small patch of forest near Punda Maria. One or two trees have, however, recently been planted in the Pretorius Kop Rest Camp.

The long, pointed, oleander-like leaves, up to 6 inches in length, are smooth and shiny and are usually arranged in whorls of four. They are easily confused with the leaves of the Matumie (*Adina microcephala*), which belongs to quite a different family, but the flowers and fruits of the two species are entirely distinct. The flowers of the Quinine-tree are small, cream-coloured and waxy and are carried on slender, branched flower-stalks. The fruits are ovoid, about ½ an inch long, with a thin, fleshy covering, becoming black and wrinkled when mature.

The bark contains a bitter principle and was, at one time, used in in the treatment of malaria, though closer investigation has shown it to be of little value. The wood is soft and light in colour and has no value as timber.

Strophanthus.

Flowers of *Strophanthus* species are often strikingly handsome, the corolla consisting of a wide-mouthed tube with five long, narrow lobes, often 3 to 4 inches in length. In most species, the lobes are pendulous and spirally twisted and it is in allusion to this character that the botanical name *Strophanthus* (from the Greek words *strophos,* twisted cord, and *anthos,* flower) is derived. The fruit consists of two pod-like structures spread at a wide angle (see Fig. 146). They break open when ripe to discharge a number of small, hard seeds, each of which is attached to a pappus of silky hairs. The seeds of some species are used by native races as the source of virulent arrow-poison and the alkaloids contained in the seeds have recently come into prominence as powerful medicinal drugs. Four species of *Strophanthus* have been recorded in South Africa and three of these have been found in the Kruger National Park, namely, *S. gerrardii, S. kombe* and *S. petersianus.*

217. Strophanthus gerrardii Stapf.

A woody climber or several-stemmed shrub which has been collected on rocky hillsides near Malelane. The bark on the older stems usually becomes thickly corky. The leaves are smooth and lance-shaped, about 1½ to 2 inches long. Flowers are brightly coloured, the corolla tube being mauve or purple and the narrow lobes bright yellow.

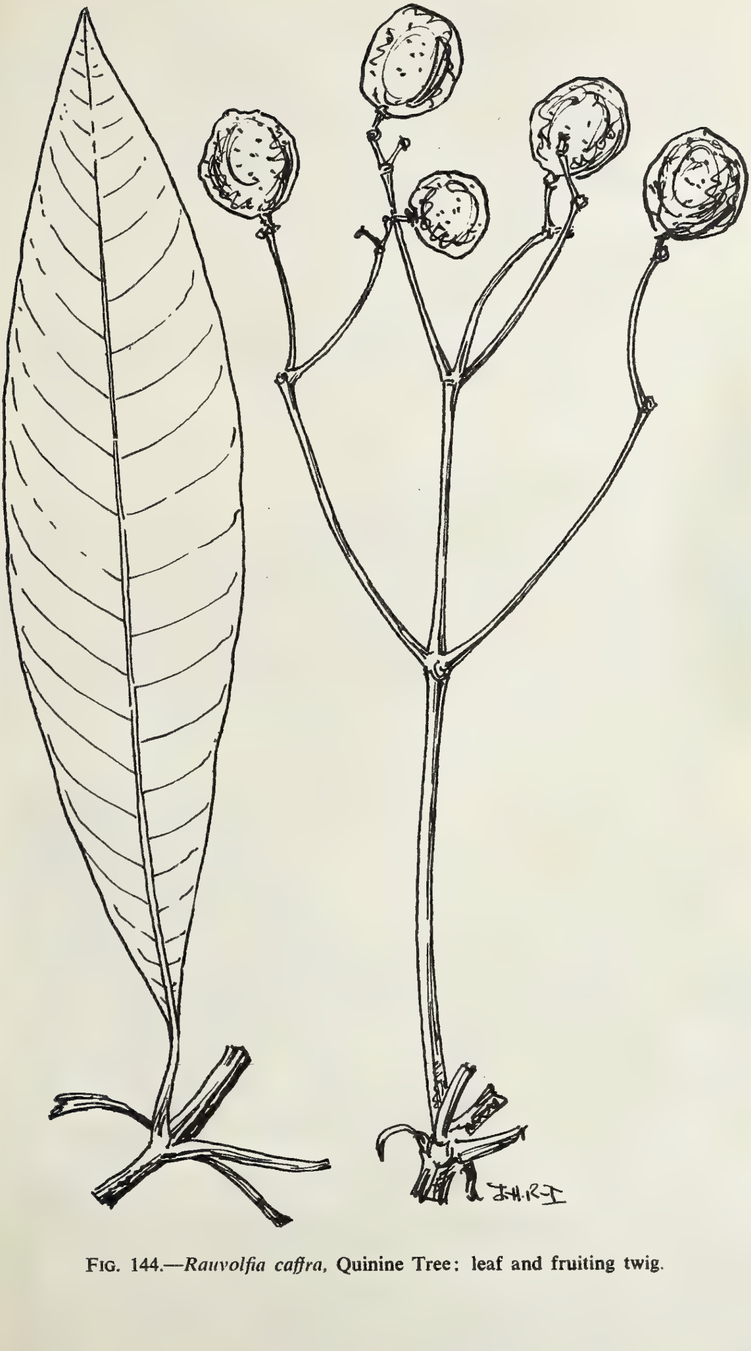


FIG. 144.—*Rauvolfia caffra,* Quinine Tree: leaf and fruiting twig.

218. Strophanthus kombe Oliv. POISON VINE; NTSULU (Shangaan). Fig. 146.

This is a tropical east African species which has recently been found in the Punda Maria area on dry, wooded hillsides. It grows as a vigorous woody climber or liane, developing a stem diameter of 4 to 6 inches near the base. The leaves are large and oval in shape, up to 5 inches in length and the young branches and leaves are roughly hairy. The flowers are creamy yellow with long drooping, twisted corolla lobes. The seeds provide one of the most powerful arrow-poisons of tropical Africa, the chief active principle being the alkaloid Strophanthine.

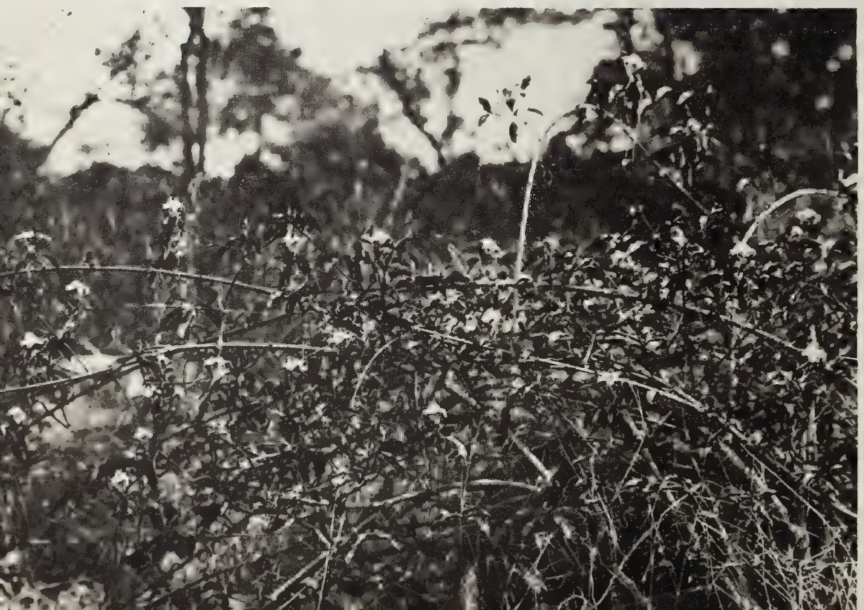
219. Strophanthus petersianus Kl. Figs. 145 and 147.

A many-stemmed shrub with slender, semi-climbing branches, also found on rocky, bush covered hillsides in the Punda Maria area. The leaves are smooth and lance-shaped to elliptical, 1½ to 2½ inches in length. Numerous showy flowers are produced in early summer, the corolla tube being lined on the inside with red, with five long, pendulous, twisted, red and cream lobes. It may be noted that there appears to be very little distinction between this species and *S. grandiflorus* (N.E.Br.) Gilg which was described from material collected at Delagoa Bay.

220. Wrightia natalensis Stapf.

The genus *Wrightia* has a peculiar distribution with 19 species in Asia and northern Australia and the above solitary species in South Africa. This species occurs in Natal, Swaziland, Portuguese East Africa and the Zoutpansberg District of the Transvaal and has been collected in a patch of forest near Punda Maria. A large tree 40 feet high and of equal spread is found in Sekukuniland and is the only one of its kind in the locality. It is regarded with superstitions awe by the natives who will not touch or chop it. They call it the tree without a name or "The Nameless Tree" and they believe it was brought down by a former

FIG. 145.—*Strophanthus petersianus,* on a rocky slope near Punda Maria. [*Photo by Dr. R. A. Dyer.*



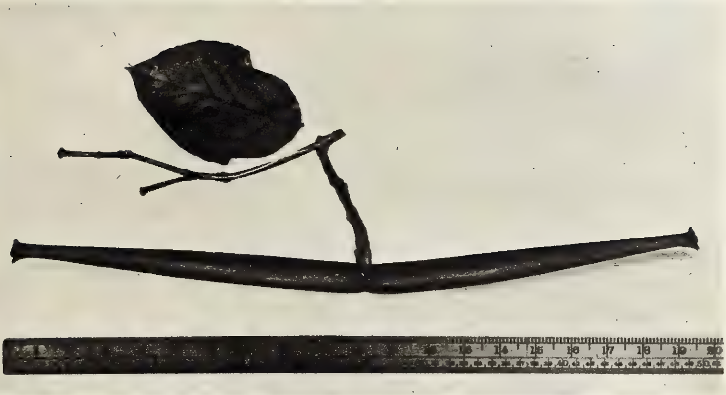


FIG. 146.—*Strophanthus kombe*, Poison Vine: leaf and fruit.

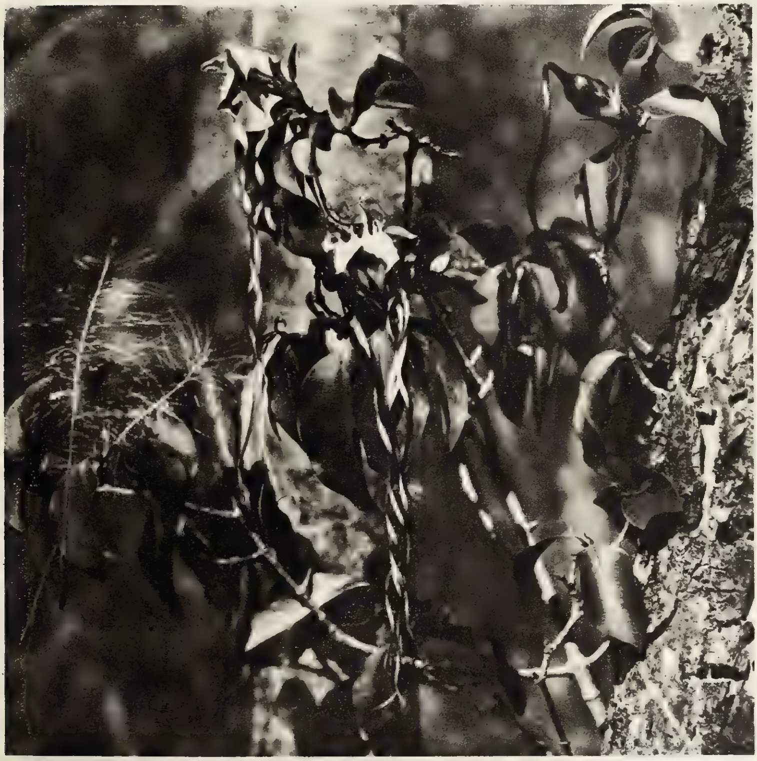


FIG. 147.—*Strophanthus petersianus:* flowers with long twisted corolla lobes. Note the seeds with the fluffy pappus on the extreme left of the photograph.
[*Photo by Dr. R. A. Dyer.*

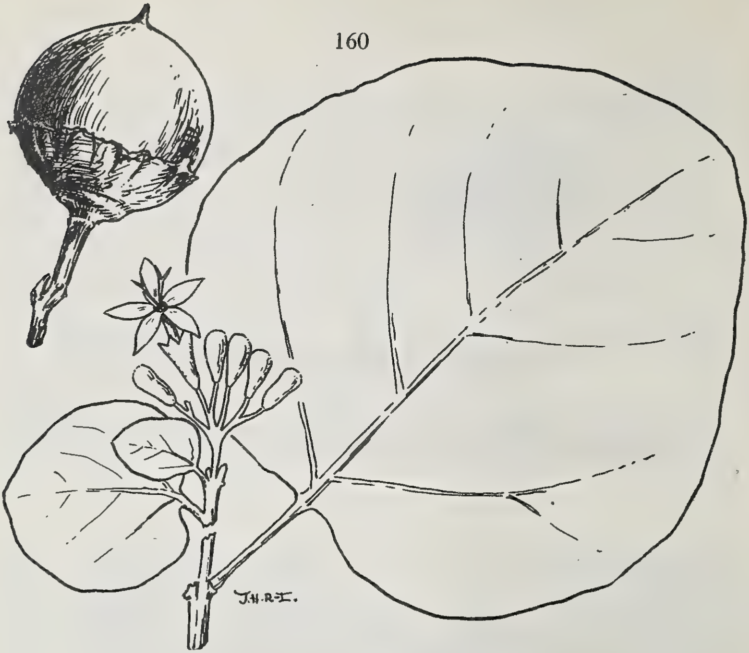


FIG. 148.—*Cordia grandicalyx*, Round-leaf Cordia, × ¾.

chief from the north. It is the subject of many legends and it is stated that no birds will nest in it, nor animals sleep beneath it.

Wrightia natalensis is a tree, usually of 20 to 30 feet in height, with a smooth, grey trunk. The leaves are opposite, lance-shaped, 2 to 3 inches long and up to 1 inch broad, tapering to the apex and soft in texture. Clusters of five-lobed, whitish flowers are produced at the ends of the branches and are said to make an attractive show. The fruits consist of pairs of drooping, slender, cylindrical pods, 12 to 15 inches long and less than ½ an inch thick. They burst open discharging numerous narrow seeds, each of which has a tuft of silky hairs attached to one end.

ASCLEPIADACEAE. Milkweed and Stapelia family.

A large family of over 1,800 species widely distributed in tropical and sub-tropical countries, composed of herbs, climbers and shrubs, including many desert succulent plants. The family is well represented in the Kruger National Park with over 30 species of herbs, succulents or soft climbers. One species worthy of mention is the Melktou (*Sarcostemma viminale*), while two other species may be described as slender, woody climbers, namely, *Cryptolepis obtusa* N.E.Br. and *Tacazzea kirkii* N.E.Br.

221. Sarcostemma viminale R.Br. MELKTOU; NNETA (Shangaan).

The name *Sarcostemma* is derived from the Greek words meaning *fleshy crown,* and refers to the structure of the flower.

The Melktou is a climber or straggly shrub with slender, succulent, leafless stems containing milky latex. Older stems sometimes become corky and up to 1 inch in thickness. Flowers are five-lobed and cream-coloured and are produced in clusters along the stems. The pod-like

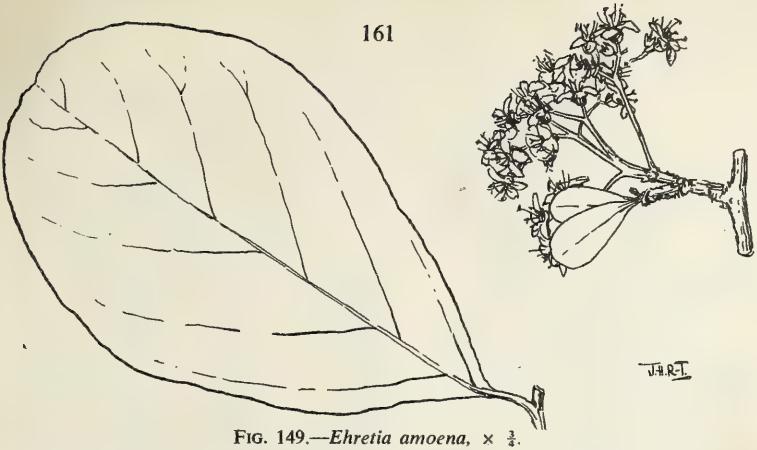


FIG. 149.—*Ehretia amoena*, × ¾.

fruits are single or in pairs, about 2 inches long, and contain numerous seeds, each with a pappus of silky hairs at one end.

It is a widely distributed species occurring from the Nile Land and Upper Guinea, through tropical Africa and into South Africa, where it is common in dry bush and scrub vegetation in the Transvaal, Natal and Cape Province. It is scattered throughout the Park and may be seen climbing over bushes in the Punda Maria Rest Camp.

BORRAGINACEAE. Heliotrope and Forget-me-not family.

Although this family is made up mostly of herbs, some of which are cultivated for their attractive or aromatic flowers, it also includes several genera of trees and shrubs. Two woody genera, *Cordia* and *Ehretia* are found in South Africa and both are represented in the Kruger National Park.

222. Cordia grandicalyx Oberm. ROUND-LEAF CORDIA; TOGWE (Shangaan). Fig. 148.

The generic name commemorates Valerius Cordus, a German botanist of the sixteenth century.

This species is a many-stemmed, deciduous shrub, forming a round, leafy bush up to 12 feet high and about the same diameter, occurring on rocky ridges in the Punda Maria area. It appears to be confined to the northern Kruger National Park and Southern Rhodesia and some well grown specimens may be seen at the foot of Dzundweni Hill, on the road from Punda Maria to Shingwedzi.

The leaves are large and roundish, about 4 to 6 inches in diameter, light green in colour and very rough to the touch. The tubular, whitish flowers with five small petal lobes are produced in clusters at the ends of the branches and are not very showy. The fruit is orbicular, about an inch in diameter, with a hard, leathery shell and a well developed, persistent calyx, giving it the appearance of a swollen acorn.

Another species, *Cordia ovalis* R.Br., is a smaller shrub, rarely more than 6 feet high, which is scattered on dry, rocky situations throughout the Park.

223. Ehretia amoena Kl. LIBHUNGELA (Swazi). Fig. 149.

The genus is named after G. D. Ehret, of Germany, who painted flowers in the eighteenth century.

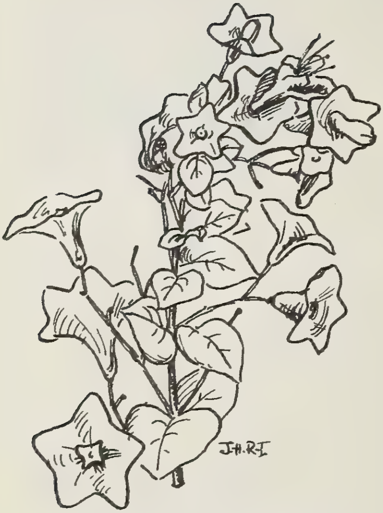


Fig. 150.—*Holmskioldia speciosa*, Parasol Flower.

Ehretia amoena is a deciduous shrub or small tree growing up to 15 feet high, sometimes forming an intricately branched crown with somewhat drooping branches. It is fairly common south of the Olifants River and is plentiful around Pretorius Kop, its distribution extending from Rhodesia and Portuguese East Africa to the northern and eastern Transvaal lowveld.

The leaves are elliptical in shape, 2½ to 3 inches long and 1½ inches wide when mature, broader above the middle, with a broad apex which is distinctly toothed. They are rough and almost sand-papery to the touch. The small, whitish-mauve flowers appear in clusters along the branches at about the same time as the young leaves, making an attractive display for a short period of a week or two. The small, dry fruits are hard and orbicular, ¾ of an inch or less in diameter.

224. Ehretia rigida (Thunb.) Druce. Deurmekaarbos.

This is a better known species, occurring in bush country practically throughout South Africa. It is rare in the Park, where it grows to a twiggy shrub up to 6 feet high with drooping branches. The leaves are smaller than in the preceding species, rarely exceeding an inch in length, and are smooth to slightly hairy, while the flowers are pale lilac in colour.

VERBENACEAE. Verbena family.

A family of trees, shrubs and herbs, found in the tropics and subtropics of both hemispheres, with relatively few representatives extending to temperate regions. Included in this family is an outstanding timber tree, the Teak of tropical Asia (*Tectona grandis*), while several shrubs of the genera *Clerodendron, Lantana, Petrea* and *Verbena* are cultivated in warmer regions of the world.

In the Kruger National Park, there are several shrubs and small trees belonging to the genera *Clerodendron, Holmskioldia, Lantana, Lippia, Premna* and *Vitex*, but they are never numerous and are unimportant components of the vegetation.

The genus *Clerodendron* is represented by two species, both of which are small, inconspicuous shrubs. *C. lanceolatum* Gürke is occasionally found in bush groups south of the Sabi River, while *C. rehmannii* Gürke has been collected on rocky hillsides near Punda Maria.

225. Holmskioldia speciosa Hutch. and Corb. Parasol Flower. Fig. 150.

Named for T. Holmskiold, a Danish botanical author. The species is a shrub or small tree which occurs in dry, rocky situations in the lowveld and has been found on the Lebombo Range near the Gorge Rest Camp.

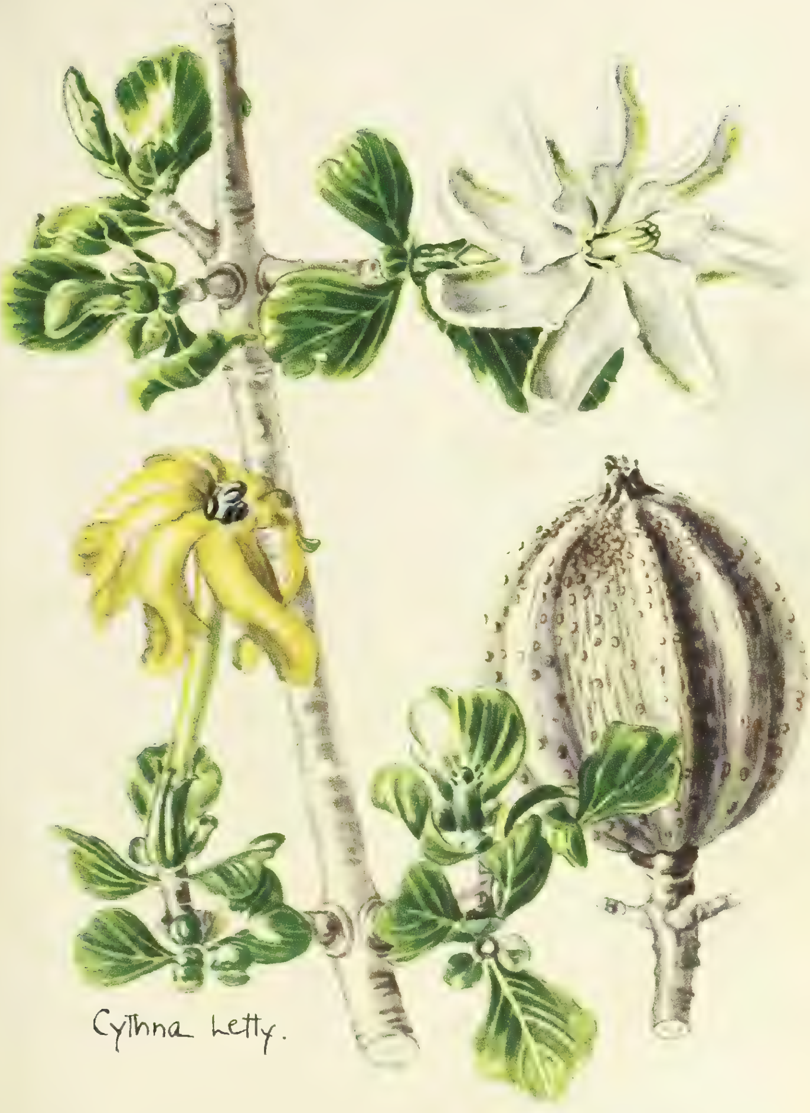

Cythna Letty.

PLATE VI.
Gardenia spatulifolia, Transvaal Gardenia (see page 173).

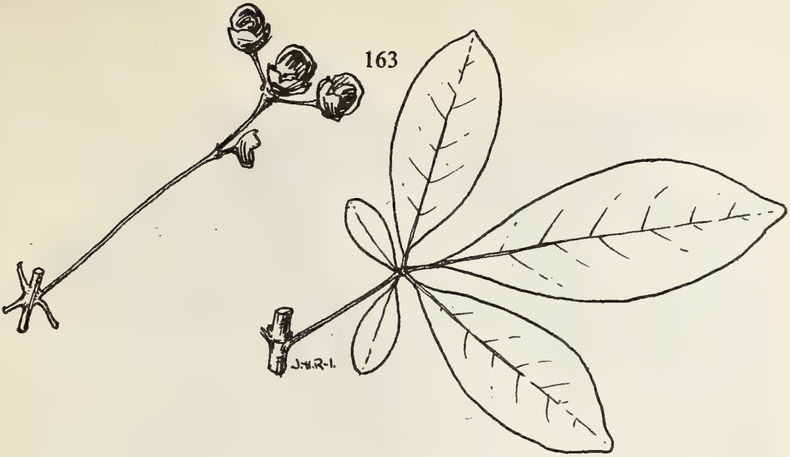


FIG. 151.—*Vitex geminata,* × $\frac{3}{4}$.

The leaves are ovate, sometimes lobed or slightly toothed, about $1\frac{1}{2}$ inches long and 1 inch broad. The flowers are attractive, consisting of a tubular, Salvia-like corolla, violet in colour, set in a large, saucer-like, dull mauve calyx. The corolla lasts only a day or two, but the calyx, which is indistinctly 5-lobed and about $\frac{3}{4}$ of an inch in diameter, persists for several weeks. This species is grown to some extent in gardens as an ornamental shrub, but is less showy than the related species from India, *H. sanguinea,* with bronze and orange flowers.

226. Lantana salvifolia Jacq. BIRD'S BRANDY; INKOBE (Swazi).

A small shrub 2 to 3 feet high which is widespread in South Africa and is found scattered throughout the Park. It has small, mauve flowers clustered in heads at the ends of the branches. The small, round fruits, also mauve in colour when ripe, consist of a hard seed surrounded by a thin soft skin which is edible.

227. Lippia asperifolia Rich. MUSUZWANE (Shangaan).

A low-growing shrub found in the southern part of the Park, with small whitish flowers grouped into heads, and aromatic leaves. The plants appear to be avoided by grazing animals and show a tendency to spread seriously in parts of the Transvaal on overgrazed veld. *L. wilmsii* Pears. is a similar species also found in the south of the Park.

228. Premna mooiensis (Pears.) Pieper.

Previously classed as a species of *Vitex,* this is a shrub or small tree up to 12 feet high which has been collected on Ship Mountain and occurs in dry, rocky situations in the Transvaal and Natal.

229. Vitex geminata Pears. Fig. 151.

A several stemmed shrub 5 or 6 feet high which occurs in the Kruger National Park near Malelane and is usually found growing in or near dry water-courses. The leaves consist of 3 to 5 oval, smooth leaflets radiating from the end of a slender leaf-stalk, and the margins of the leaves may be slightly toothed, especially towards the apex. The bark of the young twigs is shiny and reddish. Violet coloured flowers are produced on slender, branched flower-stalks at the ends of the branches. The fruits are ovoid, about $\frac{1}{2}$ an inch long consisting of a hard stone with a thin fleshy covering which turns black when ripe. The calyx persists as a shallow cup under the fruit.

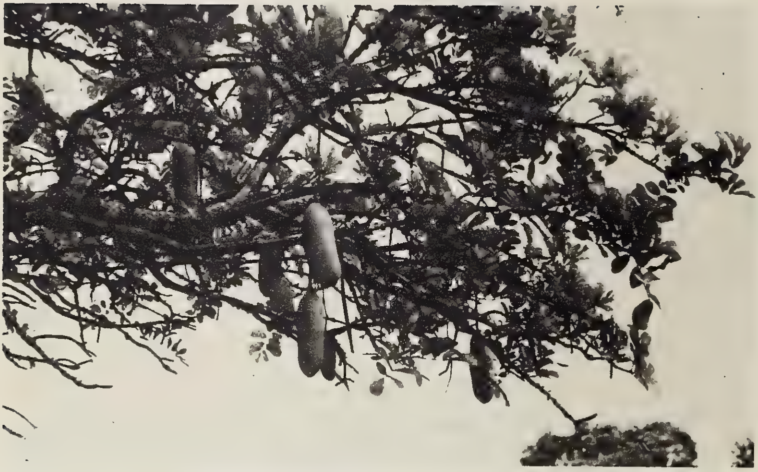


FIG. 152.—*Kigelia pinnata*, Sausage Tree.

230. Vitex amboniensis Gürke:

A much-branched shrub or small tree collected in the broken country near Punda Maria. The leaves are divided similarly to the preceding species but may have 5 or 7 leaflets which are slightly hairy. The flowers are also similar, but the fruits are much larger, being about an inch in length.

LABIATAE. Salvia family.

This is a large family of herbs and shrubs, including about 3,400 species, with few members of any economic value, though several are cultivated as ornamental or aromatic herbs and garden plants. 31 species have been collected in the Kruger National Park and several of them may be classed as softly woody undershrubs. Those that reach a stature of 3 feet or more are discussed briefly below.

231. Iboza riparia N.E.Br.

This is deciduous shrub with softly hairy, aromatic leaves, inhabiting dry, wooded hillsides and rocky places in the south of the Park. It produces masses of small whitish or pale lilac flowers at the ends of the branches in winter while the plants are completely leafless.

232. Leonotis leonitis R.Br. var. **hirtiflora** Skan.

A perennial with few, slender stems up to 3 or 4 feet high which has been collected near Pretorius Kop and Punda Maria. The orange flowers are clustered at intervals along the flowering stems. *Leonotis nepetaefolia* R.Br. is an annual species which is inclined to become a weed.

233. Nautochilus labiatus (N.E.Br.) Brem.

A soft, much-branched shrub, found in shady situations in the south of the Park. It has mauve-blue flowers in open inflorescences at the ends of the branches.

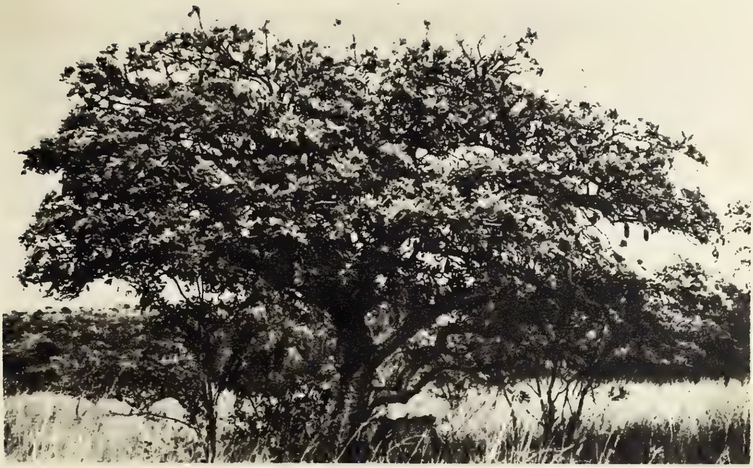


FIG. 153.—*Kigelia pinnata*, Sausage Tree, near Pretorius Kop.

234. Pycnostachys urticifolia Hook.

A slender shrub up to 6 feet high which has been found in the Pretorius Kop and Punda Maria areas. It has beautiful, clear blue flowers densely placed in pyramidal spikes at the ends of the slender flowering branches.

BIGNONIACEAE. Jacaranda family.

A family of 700 or so species, mainly trees, shrubs and climbers of tropical regions. Many are cultivated for their very showy flowers, for example, the well known Jacaranda (*Jacaranda acutifolia*) of South America and the African Tulip-tree (*Spathodea campanulata*) of tropical Africa. The former is planted in several of the older Rest Camps, such as Pretorius Kop, Skukuza, Malelane and Crocodile Bridge, while the latter is planted in Pretorius Kop Rest Camp. Another shrub from South America, *Tecoma stans*, with showy yellow flowers, is planted in the Punda Maria Rest Camp. Several ornamental climbers of the genus *Bignonia* (for example, the Golden Shower) are extensively cultivated in South Africa.

Some trees of this family are notable for their strange fruits as, for instance, the Candle-tree (*Parmentiera*) and Calabash-tree (*Crescentia*) of tropical America and the Sausage-tree (*Kigelia pinnata*) of Africa.

Four species are indigenous to the Kruger National Park, each belonging to a different genus, namely, *Kigelia pinnata, Markhamia acuminata, Rhigozum zambesiacum* and *Tecomaria capensis* (the Cape Honeysuckle).

235. Kigelia pinnata DC. SAUSAGE-TREE; MPFUNGURHU (Shangaan); UMVONGOTSI (Swazi). Figs. 136b, 152, 153 and 154.

The name Kigelia is said to be derived from a native name for the tree.

The Sausage-tree is a practically evergreen tree, growing to 35 feet in height with an extensive crown, occurring in Tanganyika, Nyasaland, Bechuanaland, Rhodesia, Portuguese East Africa, eastern Transvaal and

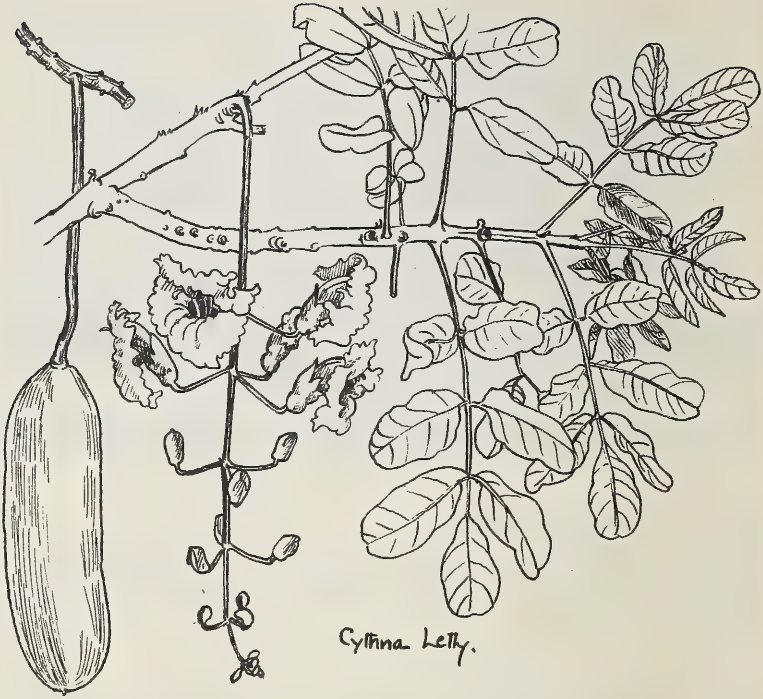

Cythna Letty.

FIG. 154.—*Kigelia pinnata*, Sausage Tree, $\frac{1}{6}$ natural size.

northern Zululand. In the Kruger National Park, it is found mainly along the larger rivers, but occurs in the open woodland around Pretorius Kop and Punda Maria. Some young trees have recently been planted in the Skukuza and Pretorius Kop Rest Camps.

The large, dark green leaves, up to 15 inches long, are pinnately compound, consisting of 3 or 4 pairs of large, oblong leaflets and a terminal leaflet. The flowers are large and bell-shaped, of a velvety, deep reddish-purple colour, and are borne in long, pendulous sprays. Baboons are frequently seen tearing off the flowers in search of nectar. The remarkable cylindrical fruits are 10 to 18 inches long and 3 to 4 inches in diameter, like grey polony sausages suspended by long, cord-like stalks 2 to 3 feet in length. The fruit contains numerous small seeds which germinate readily in the nursery, but the young trees are very slow-growing.

The timber is said to be strong and tough and, along the Zambesi, trunks of these trees are used for making dug-out canoes.

236. Markhamia acuminata K.Sch. SHIDZANYI (Shangaan).

Named after Sir Clements Markham, who introduced the quinine-producing *Cinchona* into India.

This species is a deciduous small tree up to 10 feet high which grows on rocky ridges in the Punda Maria area, its distribution extending

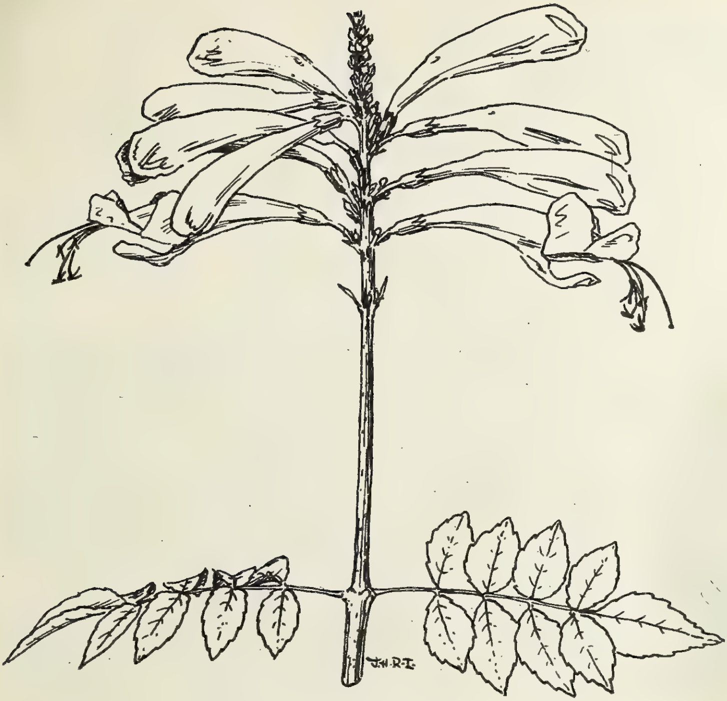


FIG. 155.—*Tecomaria capensis,* Cape Honeysuckle (see page 168).

from Tanganyika through Nyasaland and Bechuanaland to the northern Transvaal and Portuguese East Africa.

The pinnate leaves consist of two pairs of lateral leaflets and a terminal leaflet, more or less ovate in shape, 1½ to 2 inches long, with distinctly toothed margins. Flowers appear in groups on the previous season's wood before the young leaves appear. They are bell-shaped, about 1¼ inches long and are freely flecked with purple on a greyish background. Numerous flattened seeds are produced in long, slender seed-pods, about 10 to 12 inches long and ½ an inch wide, which split longitudinally when ripe, releasing the seeds.

237. Rhigozum zambesiacum Bkr.

This species occurs in Portuguese East Africa and northern Transvaal and, in the Kruger National Park, is associated with the Mopane on dry, stony slopes near Letaba and near Pafuri. It is a sparsely branched shrub up to 6 feet high with slender branches bearing short, spine-tipped lateral branchlets. The leaves are small and pinnately divided, up to about 1 inch long, consisting of two to four pairs of lateral leaflets and a terminal leaflet, and are produced in tufts along the branches.

For the greater part of the year the plant is most inconspicuous but, in favourable seasons, there is a short flowering period in early summer when the plants become literally covered with beautiful, clear yellow, funnel-shaped flowers. The fruit is a dry, thin-textured capsule about

3 inches long and less than ½ an inch wide, containing a number of flattened seeds.

238. Tecomaria capensis Spach. Cape Honeysuckle. Fig. 155.

The genus is so named from its affinity with the genus *Tecoma* which, in turn, is a simplification of the Mexican name *Tecomaxochitl* for one of these plants, from which it is apparent that botanists do not always make plant names more difficult.

The Cape Honeysuckle is a rambling, leafy shrub growing to 8 or 10 feet high with showy, red flowers. It is common in parts of the the eastern Cape Province and occurs also in Natal and eastern and northern Transvaal. In the Kruger National Park it may be observed on wooded hillsides in the southern part of the Park and it has also been found near Punda Maria.

The tubular red flowers make a showy contrast with the dark green, pinnate leaves and the plants are commonly cultivated as hedges or as isolated garden shrubs. The species is easily propagated by cuttings, but it is sensitive to frost and does not flower satisfactorily in very cold situations.

PEDALIACEAE. Sesamum family.

A small family of about 60 species distributed in the tropics of the Old World. Seven species have been recorded in the Kruger National Park, but only one of these can be classed as a woody plant, namely, *Sesamothamnus lugardii.*

239. Sesamothamnus lugardii N.E. Br. Fig. 156.

A grotesque shrub, branching from ground level, with stems swollen at the base and tapering rapidly to a height of 8 or 10 feet in a manner reminiscent of a miniature Baobab. It occurs in Bechuanaland, South West Africa and the northern Transvaal and has been collected in the Kruger National Park on rocky ridges near the Gorge Camp.

The stems are armed with short, straight spines and the leaves are small and grey in colour, ¾ to 1 inch long and broader above the middle. The flowers are in keeping with the general strangeness of the plant. They are white in colour and consist of a long, narrow, curving tube, expanding at the apex to 5 broad lobes. Near the base of the tube is a small spur about ¼ of an inch long. The fruits are flattened, thin-walled capsules 1½ to 2 inches long and about 1¼ inches wide, containing a number of flat, winged seeds. A good drawing of the flower will be seen in *A Botanist in Southern Africa* by Dr. John Hutchinson, Page 316.

ACANTHACEAE.

A family of some 2,000 species of herbs and shrubs, none of which has any claim to be of economic importance. The family is well represented in the Kruger National Park by 50 species, mostly low-growing plants, some of which bear very showy flowers and may eventually be developed as garden subjects. The few species which develop as woody shrublets more than 3 feet in height are given below. They occur mainly on bush-covered, rocky hillsides where they cannot be seen from the tourist routes.

240. Anisotes sessiliflorus C.B.Cl.

This shrub is often common on stony slopes in the north of the Park as, for instance, near Pafuri. It produces woody stems 3 to 4 feet high which bear clusters of stalkless, orange-red flowers.

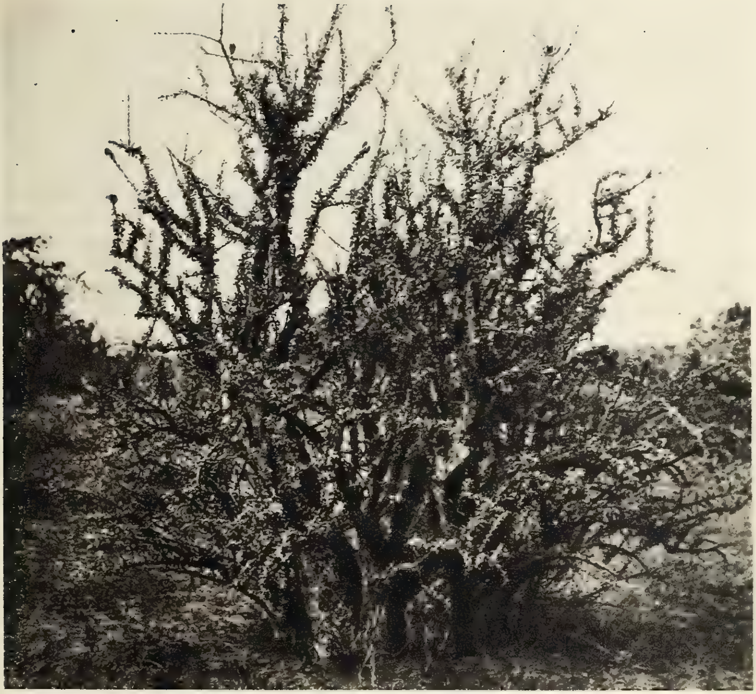


FIG. 156.—*Sesamothamnus lugardii* in the Dongola area, northern Transvaal. [*Photo by Dr. R. A. Dyer.*

241. Barleria albostellata C.B.Cl.

This species has been collected on Dzundweni Hill near Punda Maria and is a soft shrub 3 feet high with grey, velvety leaves and white flowers. It may have value as an ornamental shrub. In the Park there are several other smaller species of *Barleria*, some of which have very attractive flowers in shades of blue or orange.

242. Macrorungia longistrobus C.B.Cl.

A woody shrub found on rocky koppies near Malelane with clusters of large orange coloured flowers.

243. Ruspolia hypocrateriformis (Vahl) M.-R. var. **australis** M.-R.

A straggly shrub growing up to 6 feet high with terminal clusters of bright red, tubular flowers. It shows promise as a garden shrub but is sensitive to frost.

244. Ruttya ovata Harv.

A rambling shrub 6 feet or more in height which has been found in several wooded kloofs in the southern part of the Park. The foliage is similar to that of the preceding species, but the flowers are white flecked with mauve spots. It also has possibilities for garden purposes.

RUBIACEAE. Gardenia family.

A large family of world-wide distribution, composed of over 5,000 species of trees, shrubs and herbs. Several genera are known for their economic value, for example, *Cinchona*, which yields quinine, and *Coffea*, the source of coffee, while some are cultivated for their ornamental flowers, such as *Gardenia* and *Ixora*. A few South African species bear edible fruits, notably the Wild Medlar (*Vangueria infausta*). On the other hand, the Gousiektebossie (*Pachystigma pygmaeum*), contains a poisonous principle in the leaves and is frequently responsible for livestock losses.

The family is characterised by having opposite leaves with a small, leafy ridge (stipule) between the bases of the leaf-stalks where they are attached to the stems.

20 species of trees and shrubs from 15 genera have been recorded in the Kruger National Park. The genera to be described in the following pages are: *Adina, Crossopteryx, Gardenia, Pavetta, Randia, Rothmannia* and *Vangueria*, while those which receive no further mention are: *Canthium, Dinocanthium, Heinsia, Kraussia, Lagynias, Leptactinia, Pachystigma* and *Tricalysia*.

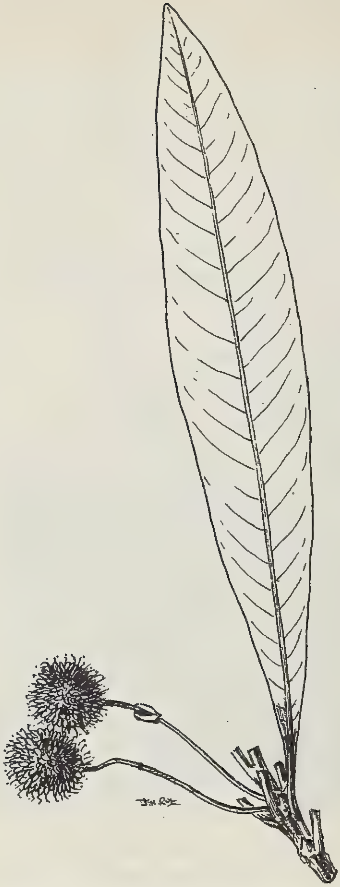


FIG. 157.—*Adina microcephala* var. *galpinii*, Matumie, × ½.

245. Adina microcephala Hiern. var. **galpinii** (Oliv.) Hiern. MATUMIE; MINGERHOUT; NHLUME (Shangaan). Fig. 157.

The generic name is taken from the Greek *adinos*, clustered, on account of the flowers being in heads.

The Matumie is a large and valuable timber tree with evergreen foliage, found along most streams and rivers in the Kruger National Park. It is particularly common along the Sabi and Olifants Rivers, where it grows to 30 or 40 feet high. Near Punda Maria, in a section not open to tourists, some magnificient specimens of 50 to 60 feet in height with a trunk diameter of 3 or 4 feet have been seen along a sheltered stream. Unfortunately, grass fires and recurrent droughts have greatly reduced these small patches of forest and many of the finest trees have already succumbed.

Our tree was, in the past, known as *Adina galpinii*, but further investigation has shown it to be only a variety of the tropical African species, *A. microcephala*. This species is widespread in tropical Africa and, with its variety included, extends southwards to Angola in the west and Portuguese East Africa, eastern Transvaal and northern Zululand in the east.

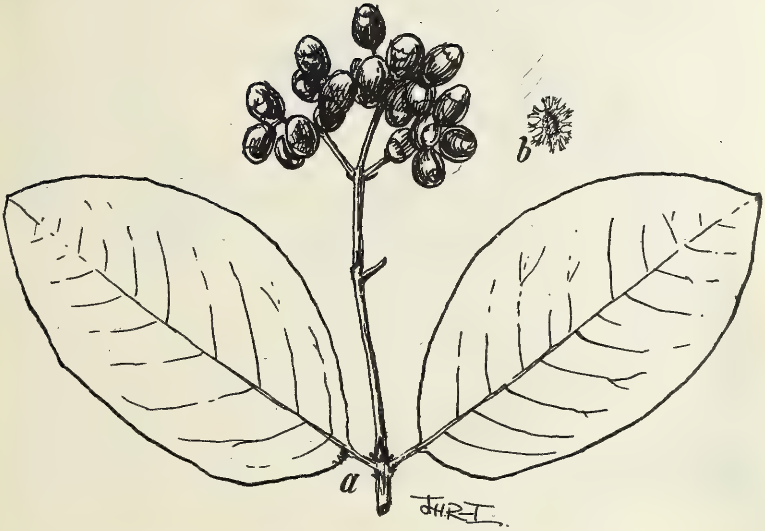


FIG. 158.—*Crossopteryx febrifuga:* a, fruiting twig, ×1; b, seed, ×2.

The long, oleander-like leaves are a glossy, dark green, 7 to 10 inches in length and 1 to 1½ inches in breadth, and are densely placed in whorls of 4 at the ends of the branches. The flowers are clustered into round heads ½ to ¾ of an inch in diameter, carried on slender stalks up to 3 inches in length. When ripe, these flower-heads are rough and brown in colour and contain a number of small seeds.

The tree yields a hard, close-grained timber, which is rather short-grained, but is useful for furniture and for parquet flooring. It resembles teak, but is not related to the true teak of India and Malaya.

246. Crossopteryx febrifuga Benth. NKOMBEKWA (Shangaan). Fig. 158.

This is a tropical African species distributed in Kenya, Tanganyika, Nyasaland, Angola and Portuguese East Africa and has only recently been recorded in South Africa, when it was found in the extreme north of the Park, near Punda Maria. It is a medium sized deciduous tree, growing to 25 feet high, showing a preference for loose, sandy soils at the foot of quartzite and sandstone ridges.

The leaves are oval in shape, 2 to 3 inches long and 1½ to 2 inches broad, roughly veined and softly hairy. The small whitish flowers are produced in dense clusters at the same time as the young leaves. The fruits are small, dry capsules, globose or ovoid, little more than ¼ of an inch in diameter. Each capsule consists of two compartments containing several small, oval, flattened seeds with delicately fringed margins [see Fig. 159 (*b*)], and it is in allusion to this character that the generic name *Crossopteryx* (from the Greek *krossoi,* fringe, and *pteron,* wing) is derived.

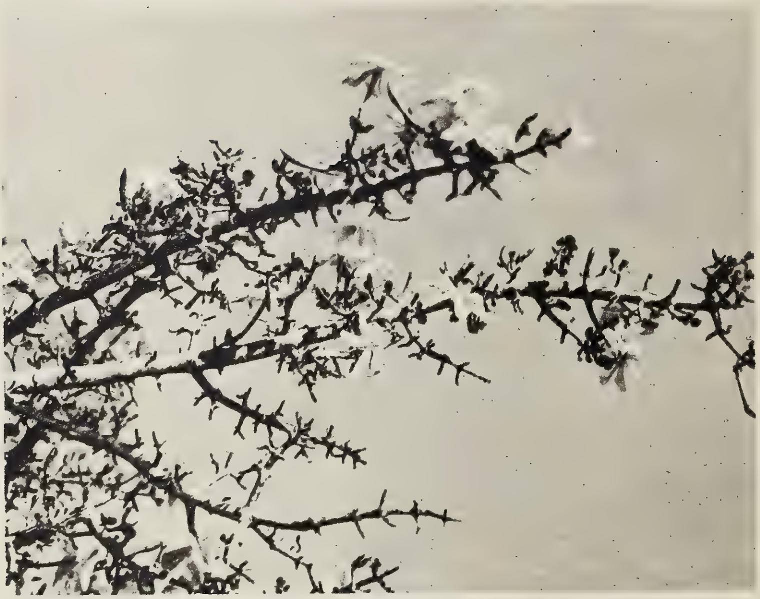


FIG. 159.—*Gardenia spatulifolia*, Transvaal Gardenia.

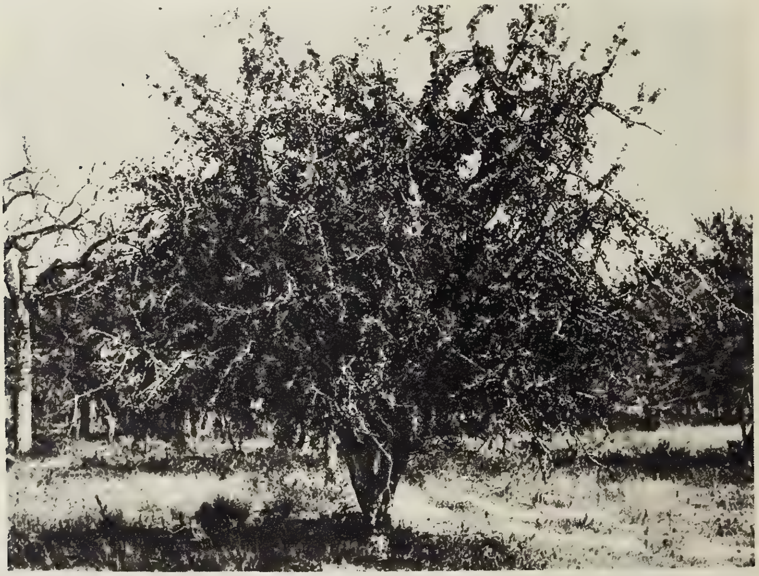


FIG. 160.—*Gardenia spatulifolia*, Transvaal Gardenia, near Skukuza.

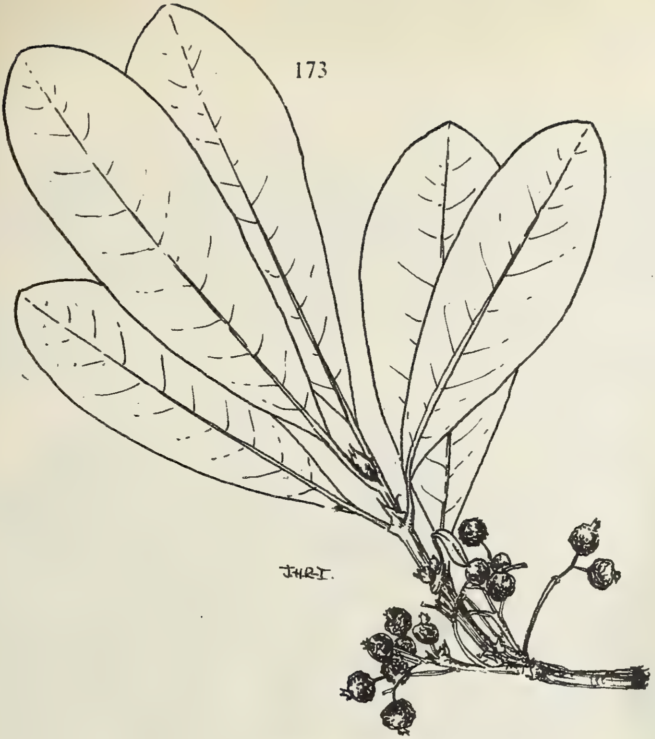


Fig. 161.—*Pavetta schumanniana* (see page 175).

247. Gardenia spatulifolia Stapf and Hutch. Transvaal Gardenia; Transvaalse-katjiepiering; Ntsalala (Shangaan). Plate VI (page 162); Figs. 159 and 160.

The genus is named after Alexander Garden, a physician of South Carolina.

The Transvaal Gardenia is a small, round-topped, twiggy tree, practically evergreen, and reaching a height of 10 to 15 feet. It is common around Skukuza, often showing a preference for low-lying, brackish situations, and is scattered in other parts of the Park. Good specimens may be seen at close quarters in the Skukuza and Gorge Rest Camps.

The young branchlets usually radiate in threes along the older stems and the bark is whitish in colour. The leaves are small and perfectly smooth (glabrous), usually about 1 to 1½ inches long and ½ to 1 inch wide, broadening above the middle to a blunt apex. The large flowers are produced irregularly from early spring to summer. The corolla consists of a narrow, tubular portion about 1½ inches long with several (usually 8) broad, spreading lobes. They are creamy white when they first open, turning yellow as they fade, and are weakly perfumed.

The fruit is an ovoid, woody structure about the size of a hen's egg, becoming grey and longitudinally ribbed as it ripens. It contains numerous seeds which germinate readily, and the young trees are easily raised, but are sensitive to frost. In the neighbourhood of Punda Maria, another species, *G. asperula* Stapf and Hutch., occurs. It appears to be practically identical with *G. spatulifolia*, but the leaves are rough to the touch, instead of being smooth as in the latter species.

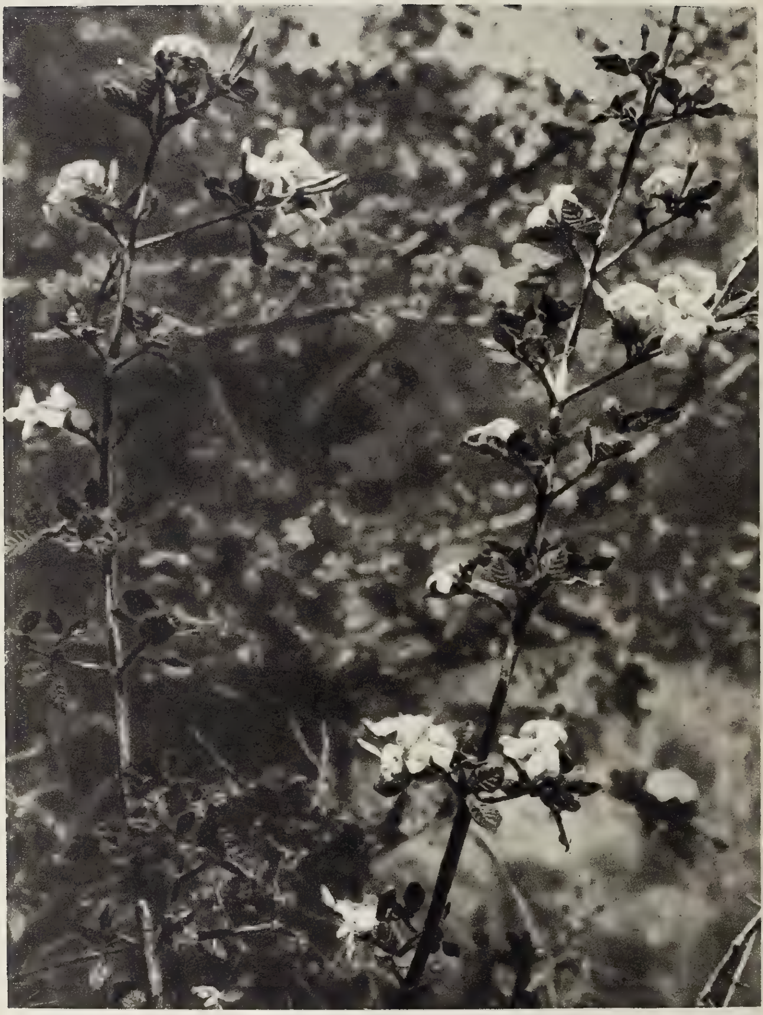


FIG. 162.—*Gardenia resiniflua* near Punda Maria.
[*Photo by Dr. R. A. Dyer.*

248. Gardenia resiniflua Hiern. Fig. 162.

This is a small, sparingly branched shrub 4 to 6 feet high, inhabiting dry, rocky ridges near Pafuri. The flowers are smaller than in the preceding species, with a narrow corolla tube about an inch long and spreading, cream-coloured lobes about an inch across. The leaves are 1 to 2 inches long, broader above the middle, conspicuously veined and softly hairy.

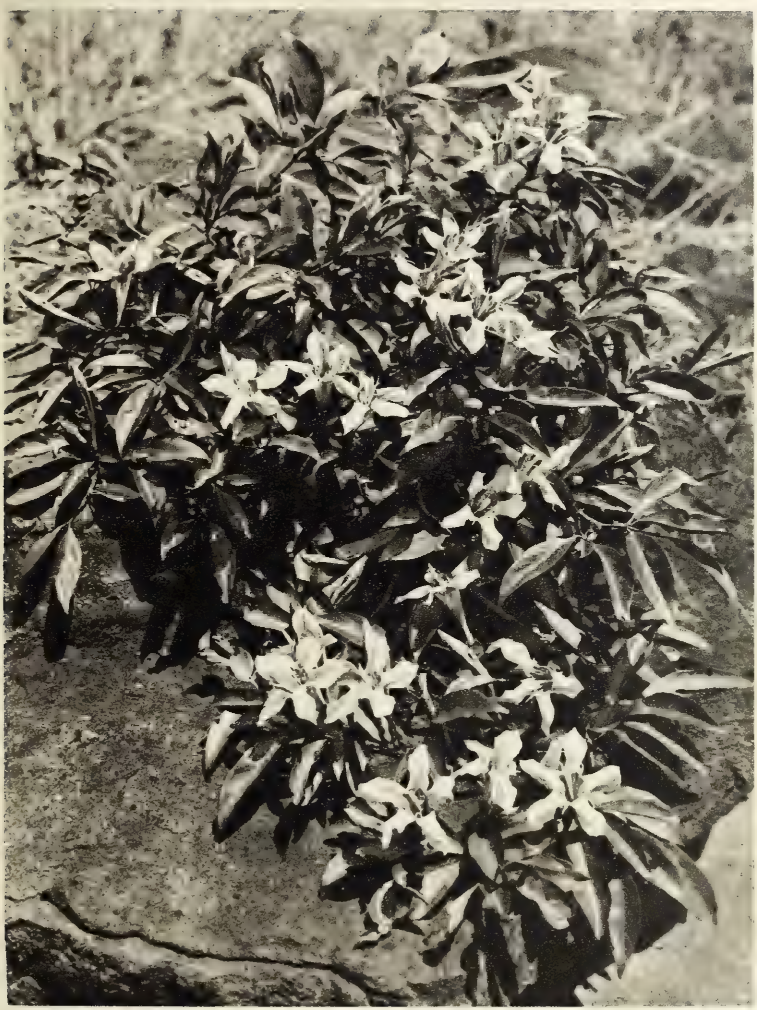


FIG. 163.—*Rothmannia fischeri*, Rhodesian Gardenia: a flowering branch. [*Photo by Dr. R. A. Dyer.*

249. Pavetta schumanniana F. Hoffm. uSAWOTI (Swazi). Fig. 161.

A deciduous shrub or small tree distributed from Tanganyika, through the Rhodesias, Bechuanaland and Portuguese East Africa to the northern, central and eastern Transvaal. In the Kruger National Park it grows as a small tree up to 8 feet high on rocky ridges around Punda Maria while, in the neighbourhood of Pretorius Kop, it is usually a stunted shrub 4 to 6 feet high.

As in other members of the family, the leaves are in opposite pairs. They are 3 to 5 inches long and 1 to 2 inches wide, broader above the middle and rounded at the apex, conspicuously roughly veined and shortly hairy. If the leaves are held up to the light, it will be noted that there are thickened, opaque dots scattered over the surface of the leaves. This is a characteristic of most species of *Pavetta* and is even more obvious in species with smooth and thinner leaves.

The white, star-like flowers are clustered in bunches and each flower has a tubular corolla with four narrow, spreading lobes, with the style well exserted. The fruits are small, spherical berries with a thin, fleshy covering, turning black when ripe and showing the small calyx persisting at the apex.

250. Pavetta catophylla K. Sch.

A small shrub up to 3 or 4 feet high with few, slender branches. The leaves are smaller than in the preceding species, though the shape is much the same. It is scattered in dry, bush-covered situations and is never common or important.

251. Pavetta edentula Sond.

This species grows to a small tree up to 10 feet high with a twisted, corky trunk and thickish, light-coloured, brittle branches. It is distributed from Nyasaland to Zululand and is very rare in the Kruger National Park, having been seen only on rocky koppies near Malelane. The leaves are smooth and pale green, long shaped, about 4 to 6 inches long and 1 to 1½ inches broad, conspicuously dotted with thickened, opaque spots.

252. Randia dumetorum Lam. siTHOLE (Swazi).

A twiggy deciduous shrub growing from 3 to 8 feet high with short, stiff, spine-tipped branchlets. It is common around Pretorius Kop and often tends to form small thickets where the grass cover has been depleted by overgrazing. It has small, oval to roundish, grey-green leaves which are softly velvety. The flowers are cream-coloured, like small Gardenia flowers, about ¾ of an inch across, with a very short corolla tube about ¼ of an inch long. The calyx and corolla are also covered with velvety hairs. The fruit is globose, about ½ an inch in diameter, leathery in texture, and encloses several seeds. The branches are reputed to be used as a fish poison by some native tribes in east tropical Africa.

253. Rothmannia fischeri (K. Schum.) A.A. Bullock. RHODESIAN GARDENIA. Figs. 108 and 163.

A slender, practically evergreen tree up to 15 feet high which is distributed from Tanganyika, through the Rhodesias to the north-eastern corner of the Transvaal, where it inhabits rocky, wooded ridges near Punda Maria.

The leaves are smooth and glossy dark green, elliptical in shape, about 2½ to 3½ inches long and 1 to 1½ inches wide. With the rains in early summer, numbers of large, funnel-shaped flowers are produced. They are carried erect on the higher branches, making an attractive display for a short period. The corolla is made up of a wide-mouthed tube about 2 inches long, with five broad, spreading lobes, and is creamy white in colour, freely flecked with purple in the throat. The fruit is ovoid and dark green, about 3 inches long. It resembles a small avocado, but consists of a thick, leathery skin enclosing a number of seeds.

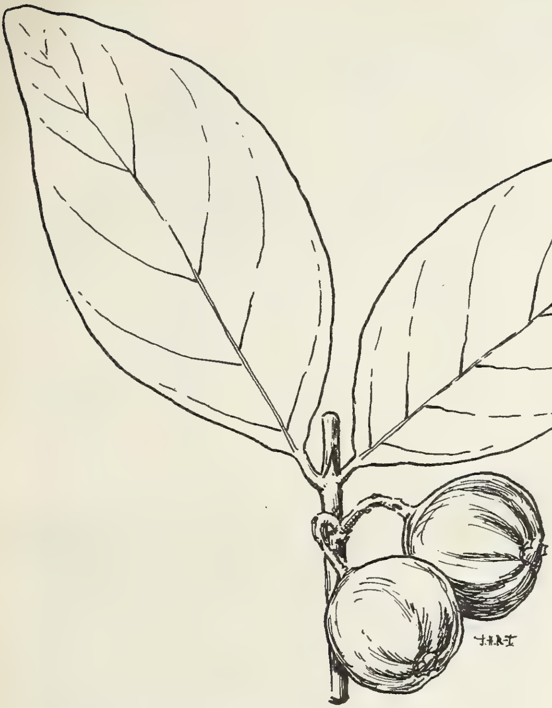


FIG. 164.—*Vangueria infausta,* Wild Medlar: fruiting branch.

254. Vangueria infausta Burch. WILD MEDLAR; WILDE-MISPEL; MPFILWA (Shangaan.) Fig. 164.

The generic name is said to be derived from the native name Voa Vanguer, used in Madagascar for one of the species.

The Wild Medlar is a small deciduous tree with few and rather thick branches, growing to a height of about 15 feet. It occurs in Nyasaland, Madagascar, Bechuanaland, Rhodesia, Portuguese East Africa, Transvaal, Natal and eastern Cape Province. It is scattered throughout the Kruger National Park, usually on sandy soil and stony outcrops, though specimens may be seen in the Letaba and Skukuza Rest Camps on a heavier type of soil.

The opposite leaves are large and oval in shape, up to 4 or 5 inches long and 2 to 2½ inches broad, the young leaves and twigs being densely covered with velvety hairs. The flowers are small, greenish-yellow in colour and are produced in dense, short-stalked clusters in early spring, at about the same time or slightly before the appearance of the young leaves.

The fruits are globose in shape, about 1 to 1½ inches in diameter, with a leathery skin which is light brown when ripe. Inside the fruits are usually 3 seeds, embedded in the pithy flesh, which is edible and has a pleasant sweet-acid flavour.

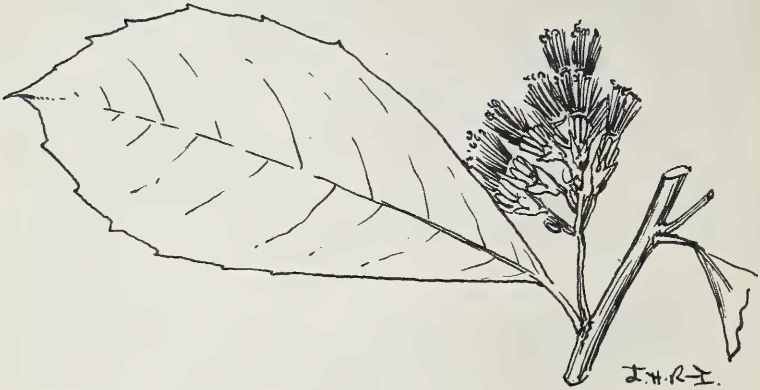


FIG. 165.—*Brachylaena huillensis.*

COMPOSITAE. Sunflower family.

A cosmopolitan family of over 13,000 species, making it the largest family of flowering plants. It is made up mainly of herbs and shrubs with relatively few trees or climbers, though some species have evolved as desert succulent plants. Members of the family are characterised by having the flowers closely packed in heads, the inner, or disc florets, usually being small while the outer row may develop as showy ray florets. Among the few species that have useful products are the sunflower, lettuce and the Jerusalem and Globe Artichokes, but the family is chiefly noteworthy for its many attractive garden flowers, for example, the dahlia, chrysanthemum, zinnia, aster and various daisies. Included in the family are a number of widespread and troublesome weeds, such as the Mexican Marigold or Khakibos (*Tagetes minuta*), Blackjack (*Bidens pilosa*), Burweed and Cocklebur (*Xanthium spinosum* and *X. pungens*), etc., while some indigenous species of the genera *Geigeria* (vermeerbos) and *Senecio* are known to be poisonous to livestock grazing on them.

The family is well represented in the Kruger National Park with about 66 species, most of which are herbaceous plants, including some which are introduced weeds (see page 14). The genera which receive some mention are *Brachylaena, Pluchea* and *Vernonia.*

255. Brachylaena huillensis O. Hoffm. Fig. 165.

A shrub or small tree up to 12 feet high with practically evergreen foliage, ocurring in Angola and the northern Transvaal. It has been collected on wooded, rocky hillsides in and around the Punda Maria Rest Camp. The leaves are leathery in texture, 2 to 3 inches long and ¾ to 1 inch wide, broader above the middle, with toothed margins. The upper surface is dark green and smooth with conspicuous veins, while the under surface is densely white felted.

Male and female flowers occur on different trees. The flowers are in small heads which are borne on short, branched inflorescences in the leaf axils. There are no conspicuous ray florets. The female florets each produce a small dry " seed " with a tuft of bristles at one end.

256. Brachylaena transvaalensis Phill. & Schweick.

This species is similar to the preceding species and though smaller in stature, it has larger leaves. It has been collected at the Hippo Pool between Skukuza and Pretorius Kop.

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257. Pluchea dioscoridis DC. Bvimba (Shangaan).

A soft shrub 4 or 5 feet high with strongly aromatic leaves, occurring mainly on river banks and silty flats and is often common in such situations in the Kruger National Park. The flower heads are small and inconspicuous. Another species, *P. leubnitzae,* is common around the Letaba Rest Camp. A decoction of the roots of *P. dioscoridis* is taken by the natives as a cure for colds.

258. Vernonia colorata (Willd.) Drake. (= *V. senegalensis* Less.).

A several-stemmed, deciduous shrub which makes a leafy growth up to 6 feet high. It has been seen around Punda Maria and Pretorius Kop, apparently showing a preference for sandy soils, its distribution extending from Upper Guinea through tropical Africa to the Transvaal and northern Zululand.

The leaves are large and elliptical, up to 4 inches or more in length, tapering to each end, usually with wavy leaf-margins. They are dark green and rough on the upper surface and grey-felted below. The flower-heads are produced in dense, showy clusters at the ends of the branches and are pale mauve to whitish in colour.

There are several additional species of *Vernonia* in the Park, but they are mostly low shrublets or annuals. One species, *V. vitellina* N.E.Br., is unusual in being a slender climber with orange-red flower-heads, being found in dry bush and thorn scrub around Punda Maria and, in the south of the Park, near Tshokwane.

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BOTANICAL SURVEY OF SOUTH AFRICA
MEMOIR No. 27

A Botanical Survey *of the* Keiskammahoek District

By

R. STORY

●

Price 10/-

UNION OF SOUTH AFRICA

DEPARTMENT OF AGRICULTURE
DIVISION OF BOTANY

BOTANICAL SURVEY MEMOIR NO. 27

A Botanical Survey *of the* Keiskammahoek District

By

R. Story
Botanical Survey Officer, Grahamstown.

1952

FOREWORD

The Native rural area of the Keiskammahoek district, in the eastern Cape Province, is well favoured by nature. One would not think so, however, to see it in its present state. Less than a century ago a good rainfall fed numerous perennial mountain streams; extensive stretches of rooigrass clothed the mountain plateaus; patches of indigenous forest flourished on mountain slopes, and excellent arable land was present in the valleys. As Schonland said in 1927, "One would think that there would be a land of milk and honey". But the natural resources of the area have not been treated wisely and there has been an alarming deterioration in the productivity of the area during the past 50 years.

In 1946 the National Council for Social Research decided to sponsor a study of the social conditions of the Keiskammahoek district as a sample Native rural area. Professor R. L. Robb was appointed Director of the project, which, from the beginning, was planned on as wide a basis as possible. The Division of Botany and Plant Pathology was approached for assistance on the botanical side and Mr. R. Story, then recently appointed as Botanical Survey Officer in charge of the Eastern Cape Province, with headquarters at Grahamstown, was made responsible for this aspect.

With characteristic thoroughness Mr. Story applied himself to his task and the present work is the result. The study became almost a full-time occupation for four years. In consequence of the detailed nature of his report it was decided to include only a brief summary in the official record of the National Council for Social Research and to publish the full account in our own series of Botanical Survey Memoirs.

Mr. Story's work is a model of careful investigation. He illuminates the path to a rational system of veld management, in the Keiskammahoek district in particular, but his results have a far wider field of application. He marshals many facts of fundamental importance on the ecology of *Acacia karroo* and these have an important bearing on Acacia scrub control throughout the Union. The full report should be studied carefully by agricultural officers and social planners. His main conclusions and the chapter on Economic Botany and Points of General Interest should be read by all.

R. A. Dyer.
Chief: Division of Botany and
Director of Botanical Survey of
the Union of South Africa.

Pretoria,
2 *January* 1952.

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My sincere thanks go to the people mentioned in the text who have given me help with these investigations. I am indebted besides to Dr. R. A. Dyer for the complete freedom he has allowed me, and for the information obtained from his photographs, manuscript reports and verbal accounts of the early history of the experiments with *Helichrysum argyrophyllum*. My fellow-members of his Division have been of help in supplying reference books, in determining and checking the plants collected and in processing the photographs. To Dr. L. E. Codd in particular I express my thanks for his quick and willing responses to numerous requests for apparatus, and for acting as intermediary between myself and various Government departments. Mr. J. P. H. Acocks has given me the benefit of his specialised knowledge, and has allowed me to make use of his unpublished work.

Miss L. L. Britten undertook the checking of this paper and suggested many valuable improvements. I am grateful to Prof. Robb and his staff for help with transport and typing, and for many kindnesses, and to the staff of the Department of Native Affairs for assistance in overcoming the practical difficulties connected with the field work, and for information also, regarding the veld and its history. Through the co-operation of the Director and staff of the Division of Meteorology, who supplied the instruments, extracted the figures from the charts and were at all times ready with advice, it was possible to do the climatic investigations summarised in Chapter 1. I gratefully acknowledge this assistance, and that of Messrs. R. A. Hoyle and F. J. Junor, who reduced the figures to their final form. I thank the Grahamstown staff of Messrs. African Explosives and Chemical Industries for the loan of apparatus, and Mrs. A. J. Harris especially for her assistance with the typing.

I referred continually to the herbarium and library of the Albany Museum while doing this work, and acknowledge with thanks the help extended to me by the Director, Dr. J. Hewitt.

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INTRODUCTION

The foundation for this work was laid early in 1947, when I was appointed Botanical Survey Officer for the Eastern Cape Province, with headquarters at Grahamstown, and began vegetation studies with special reference to the encroachment of Acacia scrub.

In that same year, the National Council for Social Research drew up a plan for investigating the conditions of Native life in the urban and rural areas of South Africa. As representative areas there were chosen respectively a Native township in the Transvaal and the Keiskammahoek district, which is situated in the Eastern Cape Province in a direct line about 100 miles north-east of Port Elizabeth and 50 miles north-west of East London. The district was chosen mainly because of the conditions of general poverty in this area. Other points in its favour as a research centre were its size of 220 square miles, making it large enough to yield reliable information without being unwieldy, its importance as a catchment area, the convenient situation of the town in its centre, and the fact that it is within easy reach of Dohne Agricultural Experiment Station, Rhodes University, Fort Cox Native Agricultural School, Fort Hare Native College and Lovedale and St. Matthews Missionary Institutions.

At the request of the Chief, Division of Botany and Plant Pathology, I took part in the investigations at Keiskammahoek, which investigations began in December 1947 under Prof. R. L. Robb, and continued until the end of February 1951. Among the matters studied were the economic and sociological organisation, health, nutrition, education and land tenure of the Native people, and the geology, topography, soils, climate, water supplies and vegetation of the district, the last being the subject of this paper.

Although the botanical survey is of the Keiskammahoek district, it has not been limited strictly to that area. Many of the features noticed have a wide application, and to have studied them solely with respect to Keiskammahoek would have been to gain sometimes an inadequate impression or even a wrong one. Hence the plants and communities of the district have been examined outside it also, wherever they have been found, and comparisons made with similar or related communities.

The observations are true in general only. As there are no known inflexible rules governing the behaviour of plants and animals, the fact can never be lost sight of that exceptions are bound to occur. They have been recorded as far as they are known.

As to the composition of the original vegetation, the conclusions drawn lack any certain knowledge of the influence upon it of the big and small game which was in former days plentiful over the eastern Cape. There are few records of such matters to be found and few facilities now for studying the animals at first hand.

For convenience of description, the vegetation has been divided into woodland and grassland, treated first separately and then together, and various types of these two divisions are considered. Some important species are singled out for special treatment. The term *woodland* is used according to the definition given in Carpenter's *Ecological Glossary*—"areas whose vegetation is composed essentially of woody plants".

To avoid repetition in the text, a glossary has been added containing the available common names which apply, and explanations of some technical terms.

Results have not been statistically analysed, and can therefore serve as indications only.

CHAPTER I

THE AREA AND ITS CLIMATE

The history of the district is included in the works of Theal and Cory, which deal with South Africa as a whole, and there is in addition a report by Jubb (1945) which is confined more particularly to Keiskammahoek. In this botanical survey the relevant historical records are mentioned in the places where they have a direct bearing upon the vegetation under discussion.

The topography and the geology have been studied by Mountain, and the soils by Murray. Their papers are to be published by the National Council for Social Research, Pretoria. I am indebted to the authors for their permission to incorporate the following short summaries which I have made from the manuscript reports.

TOPOGRAPHY

The district is roughly circular in shape, in diameter 16 miles and bounded by a ring of mountains which on the northern border are mostly over 5000 feet above sea level and have as their highest point the peak of the Third Hogsback, of 6360 feet. On the east and west, offshoots of these mountains slope down to meet the foot-hills of the southern border where the altitude is for the most part about 3000 feet. The range of altitude is 4760 feet. The basin is hilly and much dissected, and is drained by four main streams, from east to west the Rabula, the Keiskamma, the Gxulu and the Wolf, which after uniting within the district leave it on the south-western side under the name of the Keiskamma River.

GEOLOGY

The three geological formations are:—

(3) Alluvium.
(2) Dolerite.
(1) Beaufort Series.

The Beaufort Series "represents a conformable sequence of sedimentary rocks varying in character from mudstone to sandstone. . . . These sediments dip fairly uniformly over wide areas at angles up to about three degrees towards the north."

Dolerite intrusions, in the form of dikes and inclined sheets, cover 25 per cent of the total area. The dikes, varying in thickness from a few inches to hundreds of feet, are found throughout the district. Of the sheets, three main ones occur, the most southerly of these, which has been named the Zanyokwe sheet, running from Burnshill eastwards to the plateau immediately north of Debe Nek. The second, named the Nqhumeya sheet, is wide and irregular. In the east it extends to Schwarz's Krantz, just east of farm 334, and to the west it runs through Nqhumeya and the Boma Pass to turn up the Wolf River Valley, the base crossing the Wolf and continuing to below Mount McDonald. The third sheet begins near Gxulu Kop, crosses the Mnyameni River Valley and continues eastward a little north of St. Matthews, following a zig-zag course until it crosses the Dontsa Pass, after which its trend is in general southwards. It has been named the Nqolo-nqolo sheet. In addition to these three sheets, there is a complex arrangement of minor ones in the extreme north of the area.

There are on the whole, few flood-plains, and nearly all the alluvium is confined to the main water-course, the Keiskamma River.

SOILS

The soil types conform very closely to the geological structure. They are "residual and formed *in situ.* Owing to the mountainous topography, however, there has been much colluvial drift, with the result that certain soils have been displaced far from their seat of origin." The sedimentary rocks give rise to soils agriculturally inferior to those derived from the igneous rocks. They are shallower, contain fewer plant nutrients, are prone to wind and water erosion and may be waterlogged in the rainy season. They may be divided into:—

(1) Shallow gray loams with ferruginous concretions from a few inches to a few feet below them. They are easily damaged by sheet erosion and are not suitable for cultivation.
(2) Gray loams on clay, which are deeper soils, deficient in plant foods. They produce poor crops and have a tendency to become eroded into gullies.
(3) Yellowish-brown sandy loams on sandstone, occurring in small quantities.

These three together make up about 58 per cent of the total area.

The dolerite soils, which make up about 38 per cent, generally withstand ill-treatment better because of a better structure. The following may be recognised, but there are many intermediate types.

(1) Immature black clays one to two feet deep, containing boulders. They are suitable for cultivation where deep enough.
(2) Deep red clays, chocolate when virgin, red after cultivation, 6 feet deep and more, and found on the sunny side of dolerite ridges. As they are rich in plant foods except nitrogen and as they are not very erodible, they are eminently suitable for cultivation.
(3) Black, well-developed deep clays, forming more or less level plains.

Alluvial and alluvial-colluvial soils are the most fertile, have a good structure and are the most sought after by Natives for cultivation, but make up only 4 per cent of the total area.

VEGETATION

The vegetation of Keiskammahoek is predominantly woodland. In the lowlands it consists of bush and scrub, which vary in character according to the rainfall and the temperature and which may be divided into four types differing from one another fairly clearly. On the middle mountain slopes are the forests, more uniform than the scrub and bush but divisible nevertheless into a dry and a moist type. In the regions of high rainfall above the forests is found the macchia, which extends to the tops of the Amatole range.

Grassland is found in exposed positions throughout the district, but because of uncontrolled grazing much of it has been seriously damaged, and large areas have been invaded by inedible weeds. The most important of these is *Helichrysum argyrophyllum.*

Murray's soil map shows that there is no apparent relation between soils and vegetation. A few plants do show a preference for a particular soil but any character which they may impart to the vegetation is lost under the overwhelming influence of the climate, and can be brought out only with detailed study. It is emphasised that these remarks refer to Keiskammahoek only.

CLIMATE

GENERAL

Through the kindness of the Director of Meteorological Services, it was possible to set up five meteorological stations in the district. They were placed in order:—

(1) In macchia, on the lower south-east slopes of the Hogsback, at an altitude of approximately 5300 feet. The macchia, about 3 feet tall, consisted mainly of *Cliffortia paucistaminea*.

(2) In Helichrysum on the Wolf Plateau, at an altitude of about 4800 feet, on ground dipping slightly towards the north, 390 paces from beacon C at a bearing of 16° magnetic (355° true).

(3) On the border of high forest (type 6) at Wolf Ridge Forest Station, 4000 feet. The screen was set up on the lawn outside the office.

(4) On the border of dry forest (type 5) at Lenye Forest Station, about 2500 feet. The screen was in a small clearing between the forest and the thorn scrub which borders it, on a gentle grassy south slope.

(5) In scrub at Fort Cox, 1775 feet. The screen was first on a Kikuyu lawn and later in a small grassy clearing about a hundred yards from the first position. The move was made necessary because of the dusty conditions near the Kikuyu lawn.

The positions of these five stations are shown on the map which accompanies this paper. At each was a Stevenson screen containing a thermograph and a hygrograph, operated under the standard conditions recognised by the Division of Meteorology. The stations were maintained for a year, from 1st September 1948 to 31st August 1949, and the readings of temperature and humidity are set out in the tables and graphs which follow. The readings are comparable among themselves only. They cannot stand alone, for one cannot rely on the accuracy of means obtained from less than 35 years' observations (Kendrew, 1922).

The only records considered were those which were unbroken at all stations for a full day of 24 hours reckoned from midnight. The gaps in the year's records were as follows, dates inclusive:—

For humidity	*For temperature*
Sept. 19–23	Sept. 21–23
Oct. 6–Nov. 15	Oct. 10–12
Nov. 27–30	Oct. 18–Nov. 15
Dec. 10–12	Nov. 27–29
Dec. 18–30	Dec. 18–24
Jan. 1–5	Jan. 3–5
Jan. 16	Jan. 27–28
Jan. 27–28	Feb. 2–21
Feb. 2–21	Mar. 4–5
Mar. 4–5	Mar. 14–15
Mar. 14–15	May 2–6
May 2–6	May 12–18
May 12–18	May 20
May 20	May 23–June 28
May 23–June 28	July 11–14
July 6–8	July 21
July 11–14	July 27–29
July 19–Aug. 17	
Aug. 27–28	

The twelve months included a mild winter, the lowest minimum temperature recorded being one of 26°F in the Helichrysum, which would probably make the temperature at ground level somewhere near 21°F (Whitmore, 1949). There was no snow, and no freezing of the ground was noticed, but both are common occurrences above the forests on the Amatole Mountains as a rule. During cold spells the ground may remain frozen through the day and the traces of its freezing are widespread. The most conspicuous is a puffy and fissured appearance of the soil, another less conspicuous is the aggregation of small stones where the ground is level and exposed. Locally the stones may be about the size of an orange, and downwards, and their aggregation (into areas a foot or two in diameter) appears to be caused by the movements set up in the soil when it freezes and thaws (Polunin, 1934, p. 353). This phenomenon, known as solifluction or frost heaving, is well known in arctic and alpine regions, and a comprehensive list of literature references is given by Hanson (1950). As it is slight at Keiskammahoek, it would remain unnoticed by anyone unacquainted with it, and I am obliged to Dr. E. Archibald for pointing it out to me on the escarpment east of Chatha Forest Station.

The twelve months coincided also with a period of drought, from the point of view of those who read the instruments fortunately so, for the station at Fort Cox was the only one easily accessible in wet weather. The macchia and Helichrysum stations were especially difficult to reach. To give them their routine attention entailed a climb and a walk of about five miles in all and took 3¼ hours under the best conditions. The featureless Wolf Plateau was sometimes under thick mist, which could reduce the visibility to 15 yards. When this happened it was necessary to travel on a compass bearing which had been established previously.

A paper on the Keiskammahoek climate by Pilson and Higgs (ms.) gives rainfall and temperature figures and includes a general discussion. Among the points brought out are the following:—

(1) The best rains fall in March.
(2) Set-in rains are probably mainly from the south-east.
(3) Snow on the mountains falls three or four times in winter. It rarely extends below 4000 feet.
(4) The north-wester is a winter wind, almost invariably hot and dry.

Supplementary observations are as follows:—

HUMIDITY

The hygrographs gave continuous records of the relative humidity, but these measures are imperfect because, as Mayer and Anderson put it (1940, p. 194) "with the same relative humidity, evaporation from moist surfaces exposed to the air will be many times as rapid at 50°C as at 10°C." The readings would have been comparable only if the air temperature at each station had been the same. This did not happen during the year, and would have been a freak occurrence if it had happened, and for this reason the relative humidity readings are not given. Together with the current air temperature, they were used instead to calculate the saturation deficit, according to the formula Saturation Deficit $= D\left(1-\frac{RM}{100}\right)$, where D is the saturated vapour pressure at the observed temperature and RM the relative humidity (Henrici, 1926). The saturation deficit is a measure of dryness, and has the advantage that it is a definite measure in itself, without the need of complementary readings. It is not directly proportional to the rate of evaporation, and still less so to transpiration, for transpiration is evaporation plus the added complexity of life. Nevertheless, to say this is not to say that a relation does not exist. It is there, but it is a complicated one (Maximov, 1929, p. 161) and "the whole problem of atmospheric moisture in relation to ecological problems is still far from being

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Fig. 3—Times of Occurrence of Maximum and Minimum Temperatures.

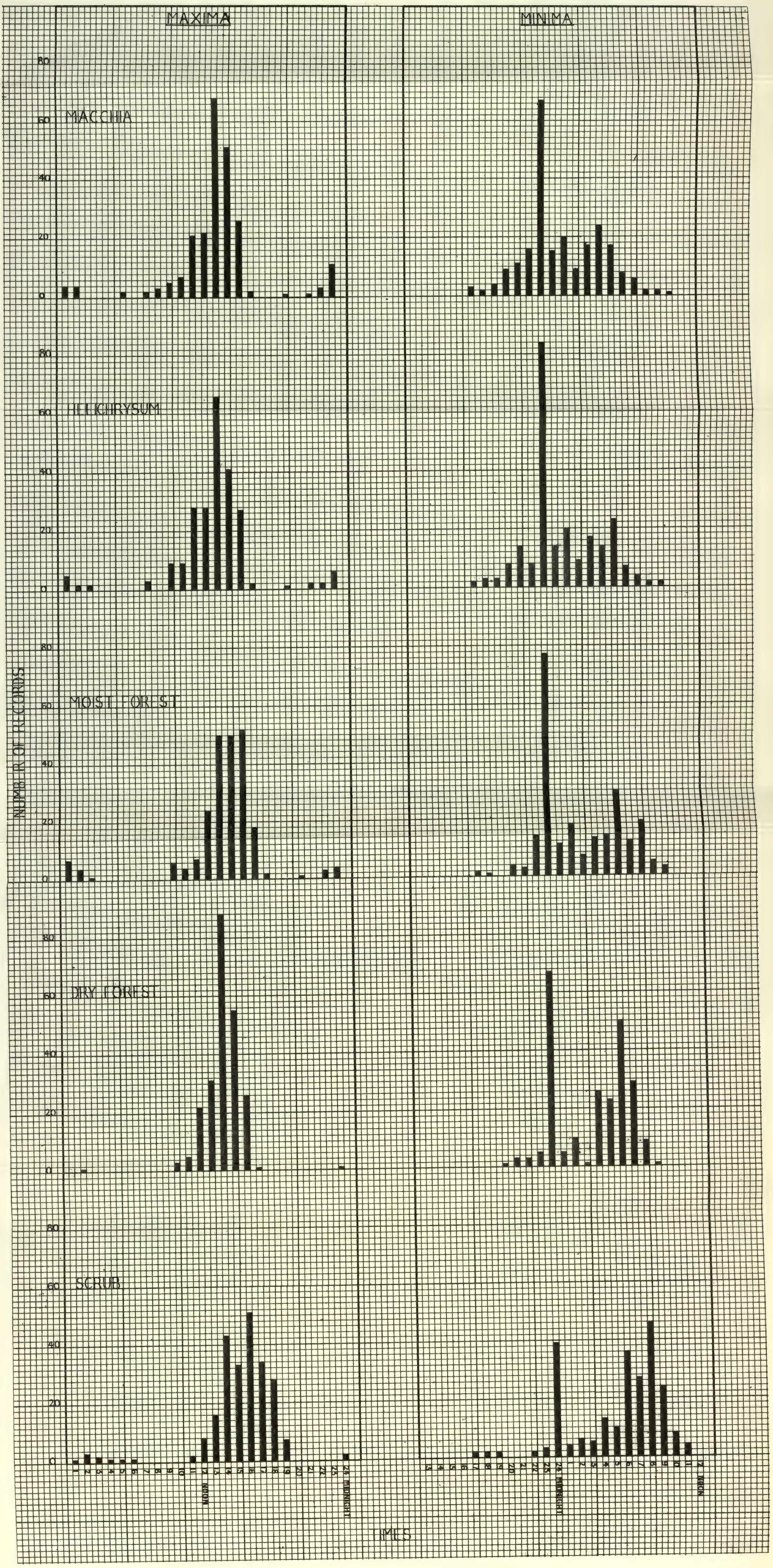


Fig. 2—Daily Range of Temperature in Degrees Fahrenheit.

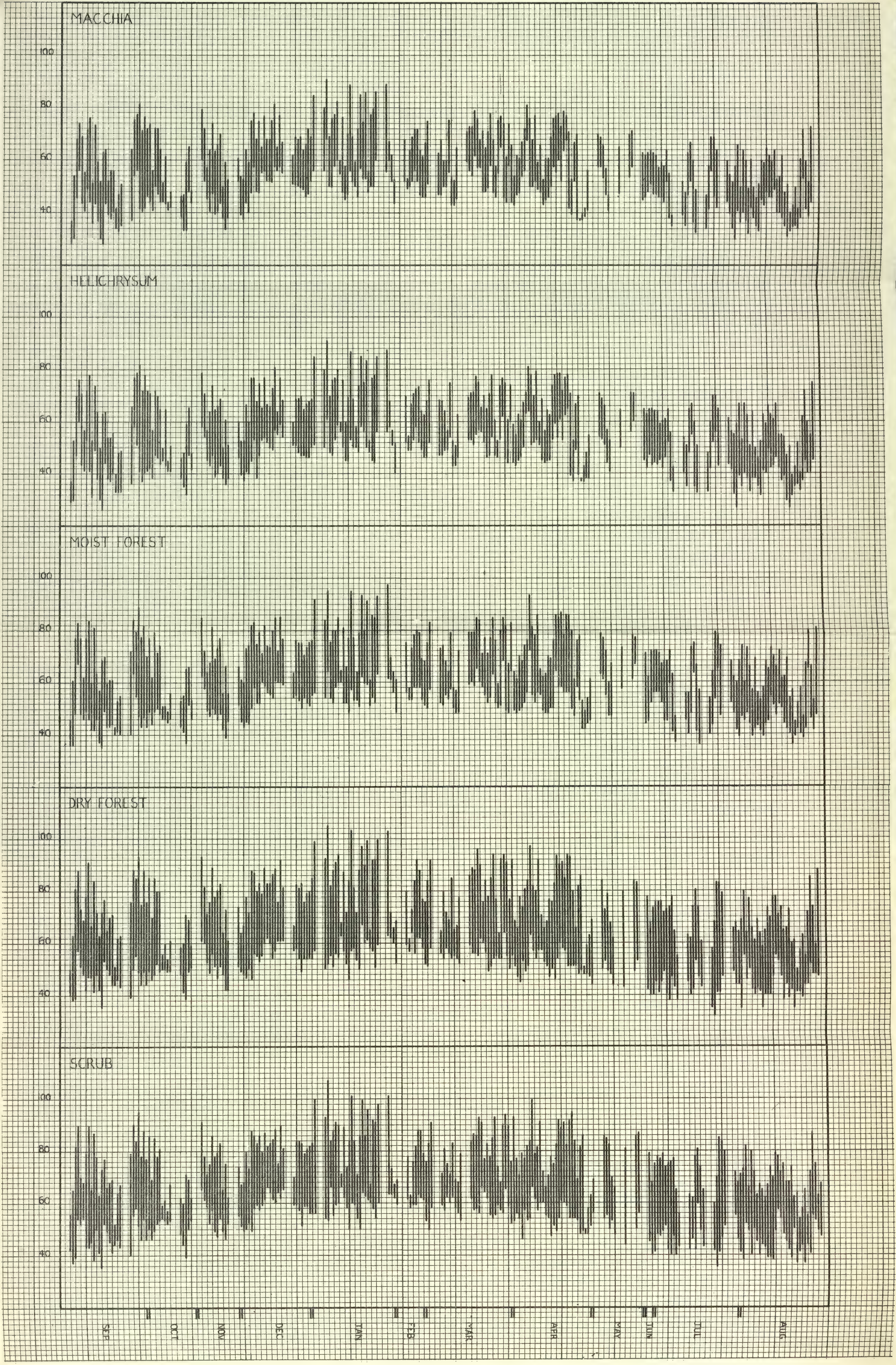


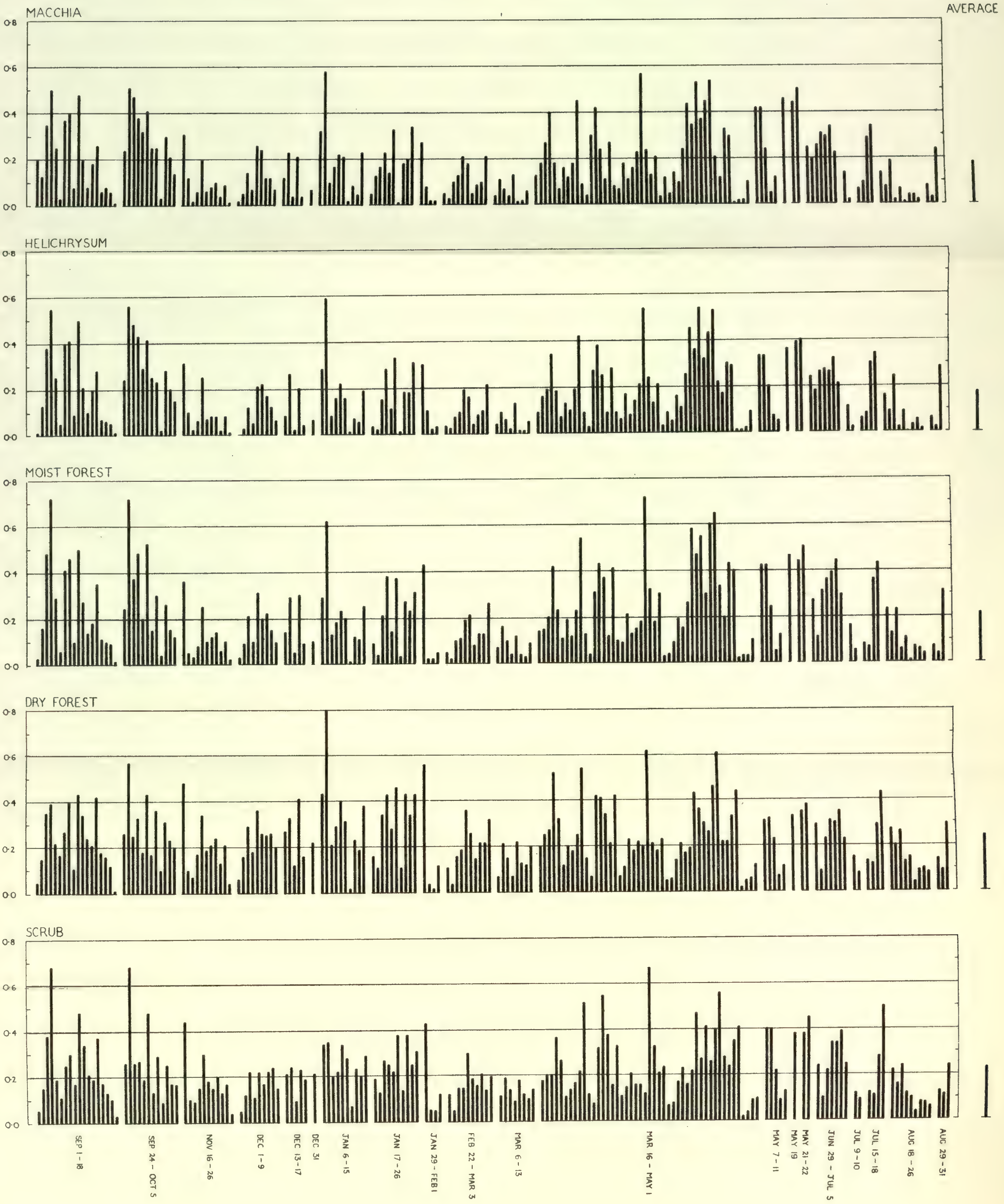
Fig. 1.

DAILY

SATURATION DEFICIT

IN INCHES OF MERCURY

SEP 48 - AUG 49



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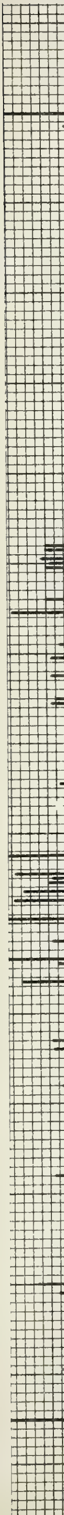


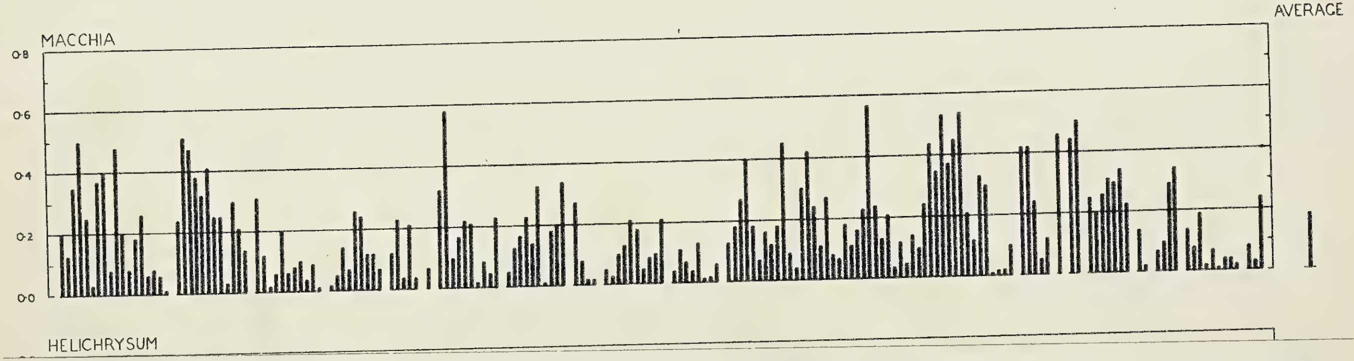
Fig. 1.

DAILY

SATURATION DEFICIT

IN INCHES OF MERCURY

SEP 48 – AUG 49



solved" (Thornthwaite, 1940, p. 27). Some common errors concerning this subject have been pointed out also by Leighly (1937). All that can be said at present is that a high saturation deficit indicates a dry habitat.

Monthly and yearly averages of the saturation deficit, computed from readings taken every two hours, are set out in Table 1 and Figure 1. There are no great differences between the stations, and no consistency in their relative order of dryness, the only consistent feature being the increasing dryness at all of them during the winter. The average saturation deficits for the year are also remarkably uniform, as has been pointed out on page 124. It appears therefore that the dryness of the atmosphere is of only minor importance in its influence on vegetation at Keiskammahoek.

TEMPERATURE

Records of temperature are set out in Tables 2–10 and Figure 2. The following are the noteworthy points:—

AVERAGE TEMPERATURE

There is practically no difference in the readings at the macchia and Helichrysum stations, and these two sets are consistently lower than those of the other three stations. Of these other three, moist forest, dry forest and scrub are warmer in order except during mid-winter (May, June and July), when the dry forest is the coldest. As this station was the only one situated at the foot of a mountain, it is possible that the low winter temperatures were caused by the lodging of cold air, but it is not clear why this did not occur during the summer as well.

TEMPERATURE RANGE

The average diurnal range was calculated for each month, with the results given in Table 7. It was invariably least in the macchia, increasing in order in the Helichrysum, moist forest, scrub and dry forest. The same general pattern is apparent in the monthly and annual ranges (Table 8).

Figure 2, besides showing the greater extremes of daily temperature in the lowlands, shows too that the difference between summer and winter temperatures is there much greater than it is in the highlands. On the whole, temperatures in the lowlands are warm and fluctuating, in the highlands cool and even. At all stations the summer rise of temperature begins in December and the winter drop in May.

MINIMUM TEMPERATURE

The absolute minimum (Table 5) and the average daily minimum (Table 6) were both generally lower in the highlands than in the lowlands, with the moist forest intermediate.

The times of occurrence of the minima were at first plotted separately for winter and summer, according to Tables 9 and 10. As the two histograms for each station were found to differ only in detail, they were combined as shown in Figure 3.

In the mountain stations the minima occur at midnight far more than at any other hour—in fact, there are about as many occurrences at midnight as there are at all the other hours combined. The next most common occurrences are in the morning, not directly after midnight as one would expect, but at 5 or 6 o'clock.

In the two lowland stations there is again a concentration of minimum temperatures at midnight, but less so than on the mountains. On the other hand, the occurrences in the morning are decidely more marked, and slightly later.

The reason for this distribution of the minima is probably bound up with cold air drainage (see pages 36 and 38). It is suggested that in the absence of complications caused by cold air drainage, the usual time of occurrence of the minimum temperature is at midnight. When cold air drainage takes place, it does so from the peaks of the mountains, and its effect must accordingly be slight and soon perceptible near the peaks and stronger and later perceptible at places progressively lower. This theory is in agreement with the results shown.

The higher lowland minima are probably due in part to the compression and consequent warming of the cold air stream as it descends from the highlands. The rise in temperature is about 1°C for every drop of 100 metres, or 5½°F for every 1000 feet (Hann, 1903, quoted by J. Phillips, 1931, p. 52).

It is of interest to note that Figure 3 gives definite grounds for the belief that the coldest temperatures occur at sunrise.

MAXIMUM TEMPERATURE

There was little difference in absolute maximum between the two upper stations or between the two lower ones (Table 3), and this was true also of the average daily maximum (Table 4). The lowland maxima were higher, usually by about 15°F.

As the times of occurrence of summer and winter maxima were shown to be essentially the same, the two were combined in the same way as the minima.

At all the stations the maxima occur mainly in the early afternoon, there being an abrupt rise in their frequency from 1400 hours (2 p.m.).

In the mountain stations there is in addition a marked grouping of the maxima at and near midnight, which may possibly be explained by a complication which sometimes follows upon cold air drainage, and which is discussed on pages 36 and 38. The complication comes about when the warm air which rises from the valleys settles in the highlands in the place of the cold air which has drained away. The exact causes which determine this circulation depend upon local conditions, and, according to the records, are unconnected with the season.

It is noteworthy that the midnight grouping is perceptible also at the scrub station at Fort Cox, which is on a ridge and therefore subject to the same phenomenon, localised, and thus on a smaller scale.

The dry forest station was on a gentle slope of 3 degrees, from which it follows that localised circulation of the air in the manner discussed would be very slight. The near-midnight maximum was recorded only twice.

RAINFALL

Rainfall figures for ten stations in and around the district are given in Tables 11–13. All the stations have about 70 per cent of their rain during the summer (October to March inclusive), and there are no unusual features.

It was at first thought that Helichrysum areas might owe their existence to a lower rainfall than fell on macchia areas, and to investigate this, three mountain gauges were set up in macchia and two in Helichrysum, as follows:—

(1) In macchia, at the meteorological station on the slopes of the Hogsback, at about 5300 feet.
(2) In macchia, in Sonntag's protection plot above the Chatha plantations, at about 4700 feet.
(3) In macchia, 50 yards from the summit of Mount Kemp on the northern side, at about 4600 feet.
(4) In Helichrysum, at the meteorological station on the Wolf Plateau, at about 4800 feet.
(5) In Helichrysum, on the wide terrace which lies on the mountain north of the Dontsa plantations, at about 4650 feet.

Results are given in Table 14. They suggest that rainfall is unlikely to be the deciding factor between macchia and Helischrysum, and add support to the views given on page 115 on the interrelations of these two communities.

For interest's sake, the rainfall from other gauges in the neighbourhood is given for the same period.

TABLE 1

AVERAGE SATURATION DEFICIT CALCULATED ON 2-HOURLY READINGS

(In Inches of Mercury)

Month	Days	Macchia		Helichrysum		Moist Forest		Dry Forest		Scrub	
						Wolf Ridge		Lenye		Fort Cox	
		Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
1948:											
September ..	25	75·5278	·2518	76·8182	·2561	85·9928	·2866	78·1013	·2603	82·0175	·2734
October	5	10·9569	·1826	10·5823	·1764	10·5571	·1760	14·5797	·2430	11·5402	·1923
November ..	11	13·8175	·1047	12·8364	·0972	15·7733	·1195	26·3190	·1994	23·4879	·1779
December ..	15	21·6696	·1204	19·8738	·1104	28·6917	·1594	42·5002	·2361	32·1944	·1789
1949:											
January	23	49·5099	·1794	46·0812	·1669	56·4907	·2047	83·9265	·3041	67·0766	·2430
February ..	8	9·3054	·0969	7·5712	·0788	9·7621	·1017	16·7174	·1741	15·0231	·1565
March	27	50·6454	·1563	45·6806	·1410	58·6433	·1810	76·6404	·2365	67·4838	·2083
April	30	79·7781	·2216	77·8850	·2163	97·7957	·2716	87·1677	·2421	88·9705	·2471
May	9	27·4560	·2542	26·8399	·2393	33·0636	·3061	27·1865	·2517	30·9570	·2866
June	2	5·4109	·2255	5·0795	·2116	4·5816	·1909	4·5755	·1906	4·0670	·1695
July	11	28·7820	·2180	26·8399	·2033	35·3945	·2681	32·4044	·2455	32·8878	·2491
August	12	11·4082	·0792	12·6049	·0875	16·5822	·1151	22·0788	·1533	19·1513	·1330
Total	178	384·2677		368·6929		453·3286		512·1974		474·8571	
Average ..		·1799		·1726		·2122		·2398		·2223	

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2, respectively.

TABLE 2

AVERAGE TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	52·5	52·8	56·9	58·2	59·8
October	14	49·6	49·1	52·9	56·4	58·4
November	12	53·8	53·2	57·6	62·7	63·8
December	24	58·8	57·8	62·4	66·8	68·1
1949:						
January	26	63·6	64·1	66·9	70·0	72·3
February	8	56·9	57·4	62·2	66·4	67·6
March	27	59·8	58·6	63·9	67·0	68·6
April	30	58·0	58·0	63·0	63·7	65·7
May	9	56·7	56·7	62·4	59·5	63·5
June	2	52·9	53·4	55·8	53·6	56·3
July	23	51·3	52·0	57·5	55·0	58·7
August	31	48·1	48·2	53·6	55·0	57·3
Av. Temp. for year ..		55·4	55·3	59·9	61·7	63·8

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

Table 3

ABSOLUTE MAXIMUM TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	81	81·8	88	93·2	95·5
October	14	71·4	71·8	78·9	84·7	85·7
November	12	78·6	79·5	85·1	92·7	91·2
December	24	81·1	80·6	85·1	92·3	90·5
1949:						
January	26	91·0	91·0	97·0	104·9	106·6
February	8	72·4	73·0	79·8	88·3	87·7
March	27	78·8	78·3	85·5	95·9	94·0
April	30	81·1	81·5	92·7	96·8	99·0
May	9	70·7	71·2	78·2	84·2	87·0
June	2	62·6	64·9	71·3	77·9	79·0
July	23	69·3	70·3	78·7	82·7	85·0
August	31	73·1	75·4	81·5	87·7	87·2

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

TABLE 4.

AVERAGE DAILY MAXIMUM TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	62·5	63·3	68·6	73·8	77·0
October	14	57·4	57·9	61·5	67·6	69·0
November	12	63·8	63·9	69·4	76·5	76·4
December	24	68·4	68·1	74·2	80·3	80·9
1949:						
January	26	71·9	73·7	79·7	82·5	86·7
February	8	64·6	65·7	71·7	78·2	77·7
March	27	68·1	67·2	74·3	81·3	81·4
April	30	65·7	66·4	73·3	79·1	79·7
May	9	63·4	64·2	71·4	77·1	79·0
June	2	62·3	63·9	66·7	72·8	73·7
July	23	58·5	58·5	66·7	71·4	72·8
August	31	56·0	57·2	63·2	68·0	69·8
Av. daily Max. for year		63·8	64·5	70·5	76·0	77·5

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

TABLE 5

ABSOLUTE MINIMUM TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	28·0	26·0	35·3	34·7	35·3
October	14	32·6	32·5	37·5	39·0	39·5
November	12	33·5	35·1	39·3	42·0	46·0
December	24	37·0	37·0	43·1	46·5	49·0
1949:						
January	26	45·5	44·0	49·0	46·0	50·0
February	8	44·1	40·5	48·9	52·0	58·5
March	27	43·2	42·7	48·0	49·0	50·5
April	30	37·1	37·5	42·3	45·0	40·0
May	9	41·0	38·3	45·5	42·8	44·0
June	2	45·5	42·5	44·4	39·8	39·7
July	23	32·0	33·0	36·5	32·0	34·7
August	31	30·0	27·5	36·5	35·0	37·0

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

Table 6

AVERAGE DAILY MINIMUM TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	40·3	40·1	45·2	45·8	46·2
October	14	41·5	41·6	45·9	48·1	49·7
November	12	43·8	43·9	48·8	50·9	53·8
December	24	49·7	48·3	53·4	54·8	57·9
1949:						
January	26	53·2	51·6	56·2	56·4	58·4
February	8	50·0	50·2	54·8	58·8	60·5
March	27	50·9	49·8	54·9	55·1	57·9
April	30	49·6	49·6	53·0	52·0	54·3
May	9	50·6	49·7	55·9	48·3	51·0
June	2	45·6	42·5	44·6	41·4	42·3
July	23	43·6	41·2	48·8	43·2	45·4
August	31	39·6	37·9	44·5	43·9	45·0
Av. daily Min. for year ..		46·9	45·6	50·6	50·2	52·2

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

Table 7

AVERAGE DIURNAL RANGE OF TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest Wolf Ridge	Dry Forest Lenye	Scrub Fort Cox
1948:						
September	27	22·2	23·16	23·4	28·1	28·7
October	14	15·2	16·2	15·6	19·5	19·2
November	12	20·0	20·1	20·6	25·9	22·6
December	24	18·7	19·0	20·8	25·8	22·9
1949:						
January	26	22·3	22·7	23·4	30·1	27·9
February	8	14·5	15·4	16·8	19·3	17·2
March	27	17·2	17·5	19·7	26·2	23·5
April	30	16·0	16·7	20·3	27·0	25·4
May	9	13·1	14·5	15·5	28·7	28·0
June	2	16·7	21·4	22·1	34·25	31·4
July	23	14·8	16·9	17·9	28·0	27·4
August	31	16·4	19·0	18·3	24·1	25·1

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

TABLE 8

MONTHLY RANGE OF TEMPERATURE

Month	Days	Macchia	Helichrysum	Moist Forest	Dry Forest	Scrub
				Wolf Ridge	Lenye	Fort Cox
1948:						
September	27	53·0	55·8	52·7	58·5	60·2
October	14	38·8	39·3	41·4	45·7	46·2
November	12	45·1	44·4	45·8	50·7	45·2
December	24	44·1	43·6	42·0	45·8	41·5
1949:						
January	26	45·5	47·0	48·0	58·9	56·6
February	8	28·3	32·5	30·9	36·3	29·2
March	27	35·6	35·6	37·5	46·9	43·5
April	30	44·0	44·0	50·4	51·8	53·0
May	9	29·7	32·9	32·7	41·4	43·0
June	2	17·1	22·4	26·9	38·1	39·3
July	23	37·3	37·3	42·2	50·7	50·3
August	31	43·1	47·9	45·0	52·7	50·2

Note: Wolf Ridge, Lenye and Fort Cox represent woodland types 6, 5 and 2 respectively.

Table 9

TIMES OF OCCURRENCE OF MINIMUM TEMPERATURES

		Hours																							
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Macchia ..	Summer	9	9	3	10	15	7		1											1	2	5	7	9	32
	Winter	6	11	6	7	9	10	8	5	2	2	1							3	1	2	4	4	7	34
Helichrysum	Summer	5	12	4	10	9	15	2	1		1								1		1	2	6	5	36
	Winter	8	8	5	7	5	8	5	3	2	1								1	3	2	6	8	3	47
Moist Forest	Summer	3	7	4	6	9	23	6	7										2	1		2		7	33
Wolf Ridge..	Winter	8	11	3	7	5	7	6	12	5	3											2	3	7	43
Dry Forest ..	Summer	1	5		18	17	21	10	1													2	1	2	32
Lenye ..	Winter	4	5	1	8	5	29	19	8	1											1	1	2	3	35
Scrub ..	Summer	1	2	2	9	5	24	17	20	7	1	1											1	1	19
Fort Cox ..	Winter	3	4	3	4	5	12	9	26	17	7	3						2	2	2			1	2	20

Table 10

TIMES OF OCCURRENCE OF MAXIMUM TEMPERATURES

		Hours																							
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Macchia ..	Summer	1	3						2	3	5	3	12	10	29	24	13	2						1	2
	Winter	3	1				2					4	9	12	38	27	13				1		1	2	9
Helichrysum	Summer		1	2					3		5	5	17	12	23	20	17	2					1		2
	Winter	5	1								4	4	11	16	42	21	10				1		1	2	4
Moist Forest	Summer	2	2	1							4	2	2	13	23	20	26	10	2			1		1	1
Wolf Ridge..	Winter	5	2								2	2	5	11	27	30	25	8						2	3
Dry Forest ..	Summer		1								2	1	15	16	39	19	15	1							1
Lenye ..	Winter										1	4	7	15	49	35	11								
Scrub ..	Summer	1	1	1								2	6	8	20	16	23	18	12	2					
Fort Cox ..	Winter		2	1	1	1	1						2	8	23	17	27	16	16	5					2

TABLE 11

ANNUAL RAINFALL

	Fort Cox		Keiskammahoek		Dontsa		Lenye		Rabula	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930	22·33	56	24·34	61	31·55	89	27·50	79	29·52	87
1931	29·31	60	30·36	81	39·76	81	34·12	94	38·87	75
1932	27·02	65	25·48	60	33·78	111	31·63	78	31·85	81
1933	21·27	58	22·83	52	29·31	103	26·79	73	23·45	81
1934	28·89	68	22·79	47	34·28	95	33·91	86	33·10	83
1935	28·89	60	28·15	57	33·96	92	32·26	77	31·80	65
1936	25·42	63	22·96	56	29·66	97	28·50	88	28·97	68
1937	20·06	57	19·03	50	25·48	91	27·91	65	23·70	81
1938	23·38	63	27·67	73	32·40	107	35·46	94	31·52	90
1939	24·77	72	30·70	73	33·05	100	31·68	93	35·78	100
1940	22·65	51	24·43	56	23·78	93	33·11	75	28·68	74
1941	20·76	54	19·33	49	18·68	80	26·30	70	24·30	71
1942	24·79	87	27·50	68	26·29	96	32·18	82	32·11	77
1943	25·90	78	30·63	83	29·87	94	30·41	86	32·95	100
1944	21·43	62	20·76	63	19·38	82	24·04	75	28·41	75
1945	14·39	45	13·81	53	13·29	70	16·41	63	18·94	70
1946	21·50	68	20·05	58	22·17	99	25·29	92	26·87	92
1947	21·55	54	19·40	75	25·27	116	25·25	99	27·08	64
Mean	23·57	62	23·90	62	27·89	94	29·04	81	29·33	80
Winter rain	30%		29%		30%		30%		32%	

Table 11—(*continued*)

ANNUAL RAINFALL

	Chatha		Wolf Ridge		Isidenge		Hogsback		Evelyn Valley	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930	31·12	108	43·76	100	45·91	124	56·46	81	70·76	111
1931	39·85	118	41·44	98	45·72	136	48·61	77	74·85	126
1932	35·33	126	42·48	95	45·95	147	46·35	79	69·54	146
1933	34·60	112	39·82	106	36·06	133	37·14	113	57·20	119
1934	41·29	109	45·13	97	51·28	135	37·31	108	82·30	134
1935	34·73	98	44·45	92	45·07	123	53·06	118	75·31	136
1936	36·39	93	46·95	104	45·66	130	53·64	120	76·94	126
1937	34·32	67	40·44	101	45·64	138	44·16	118	60·23	102
1938	35·75	87	46·90	121	48·29	156	62·58	142	64·34	134
1939	48·35	98	54·17	117	49·93	132	55·22	131	52·92	150
1940	37·32	73	46·88	102	40·49	116	48·48	102	53·96	150
1941	31·43	81	38·11	95	39·35	107	42·82	102	49·06	144
1942	55·55	94	49·64	119	49·11	141	43·88	112	61·11	152
1943	43·05	83	43·93	108	50·80	124	59·80	107	62·14	142
1944	30·60	75	37·79	94	34·39	99	34·90	84	50·56	141
1945	24·46	68	25·42	95	31·11	95	38·52	97	41·21	133
1946	36·68	79	39·76	116	39·64	111	42·80	82	52·25	150
1947	35·58	88	38·81	120	41·56	138	49·12	123	51·98	164
Mean	37·02	92	42·55	104	43·66	127	47·49	105	61·48	137
Winter rain	26%		28%		27%		30%		28%	

TABLE 12

SUMMER RAINFALL

(October—March inclusive)

Year	Fort Cox		Keiskammahoek		Dontsa		Rabula		Lenye	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930–31	14·86	38	—		17·12	54	15·50	44	16·34	47
1931–32	17·24	32	—		23·31	65	21·13	41	21·27	45
1932–33	16·99	46	—		25·12	79	18·20	64	20·91	57
1933–34	23·72	50	20·86	43	29·85	75	26·73	58	28·27	68
1934–35	14·15	32	14·00	24	19·64	58	14·15	35	16·05	46
1935–36	16·10	37	14·54	32	19·17	54	15·39	36	17·22	44
1936–37	17·33	46	17·75	38	21·30	71	22·90	60	23·22	60
1937–38	14·77	36	16·99	40	21·39	68	20·82	55	22·67	51
1938–39	19·82	49	24·09	49	27·77	66	28·75	61	27·26	62
1939–40	18·94	52	21·92	48	19·38	64	23·30	55	27·07	61
1940–41	10·68	28	11·85	32	11·62	61	14·68	52	14·49	41
1941–42	16·72	44	16·42	35	16·25	51	18·30	43	24·46	49
1942–43	16·40	49	17·33	41	18·24	63	22·51	57	18·21	51
1943–44	21·72	56	24·72	52	22·93	69	25·63	59	24·30	58
1944–45	7·83	23	8·42	30	8·75	40	12·31	43	11·64	40
1945–46	14·03	41	13·74	39	14·70	65	18·25	58	15·73	50
1946–47	15·52	42	12·90	35	15·18	51	17·47	39	18·11	50
1947–48	16·89	35	17·59	49	20·42	75	21·44	47	19·18	57
Mean	16·32	41	16·87	39	19·62	62·7	19·86	50	20·38	52

Table 12—(*continued*)

SUMMER RAINFALL

(October—March inclusive)

Year	Chatha		Wolf Ridge		Isidenge		Hogsback		Evelyn Valley	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930–31	20·50	66	24·21	56	26·25	74	34·19	48	44·68	66
1931–32	26·09	80	28·32	67	27·23	90	30·63	48	39·57	101
1932–33	35·15	87	30·73	65	30·40	96	29·40	52	46·26	94
1933–34	34·71	89	39·87	75	41·84	96	27·84	82	60·00	89
1934–35	24·40	68	24·19	56	26·14	76	27·54	71	47·41	88
1935–36	19·59	56	26·49	56	28·60	75	31·13	67	48·59	80
1936–37	25·88	59	31·78	75	38·99	101	41·52	79	63·33	84
1937–38	29·29	53	32·36	78	37·03	101	35·07	82	44·25	50
1938–39	36·52	59	40·99	83	43·42	96	48·56	97	55·92	91
1939–40	29·92	60	42·10	74	30·87	80	39·53	83	40·70	104
1940–41	26·04	53	28·69	73	28·71	75	32·48	66	34·86	100
1941–42	20·80	55	32·29	67	31·19	79	33·41	69	39·58	97
1942–43	32·87	54	29·21	72	24·50	87	28·78	71	42·48	92
1943–44	36·75	61	34·83	73	35·73	74	41·40	63	44·34	94
1944–45	17·40	49	19·47	57	18·71	57	19·35	50	26·85	87
1945–46	25·65	52	27·87	71	28·87	71	29·85	67	38·78	95
1946–47	24·23	48	25·77	63	28·34	76	31·83	64	33·48	89
1947–48	28·02	51	30·02	72	31·07	22	33·27	72	38·93	102
Mean	27·43	61	30·51	69	30·99	79	33·10	68	43·88	89

Table 13

WINTER RAINFALL

(April—September inclusive)

Year	Keiskammahoek		Fort Cox		Dontsa		Lenye		Rabula	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930	—		6·83	19	13·29	34	8·91	29	10·73	34
1931	—		9·85	21	15·55	22	13·36	43	18·17	33
1932	—		10·23	26	10·22	35	10·51	25	12·61	30
1933	4·50	11	5·50	15	5·47	28	6·35	21	6·44	22
1934	4·80	14	6·58	22	6·12	24	8·14	28	6·94	30
1935	13·78	28	14·48	30	17·20	40	16·30	32	17·93	32
1936	5·29	15	7·41	17	6·60	32	7·50	29	6·35	17
1937	2·81	11	3·35	18	4·40	23	4·41	17	3·87	24
1938	9·64	31	8·86	22	9·76	41	11·12	33	10·32	39
1939	8·21	27	6·41	28	9·97	36	8·60	38	9·05	40
1940	8·06	19	6·71	14	7·35	32	9·74	24	8·70	19
1941	5·32	15	5·77	19	4·95	21	6·59	22	7·16	24
1942	6·41	23	5·61	33	5·62	32	7·33	28	7·18	24
1943	10·24	30	9·63	32	10·06	34	10·75	33	12·59	41
1944	7·88	30	7·92	28	4·89	33	8·72	33	12·65	34
1945	3·65	15	2·66	12	3·61	21	3·28	22	3·54	22
1946	5·05	19	4·40	25	4·65	35	6·03	36	5·91	33
1947	6·90	34	4·93	18	8·24	47	7·82	45	8·53	25
Mean	6·84	21	7·06	22	8·22	32	8·63	30	9·37	29

Table 13—*(continued)*

WINTER RAINFALL

(April—September inclusive)

Year	Chatha		Isidenge		Wolf Ridge		Hogsback		Evelyn Valley	
	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days	Rain	Rainy days
1930	10·52	41	18·91	48	13·85	37	22·27	33	24·14	37
1931	13·87	43	18·38	51	12·68	37	17·98	29	31·22	44
1932	9·61	40	13·00	51	13·38	32	16·95	27	23·95	39
1933	7·67	26	8·29	40	9·90	32	9·30	31	14·81	36
1934	8·23	29	9·86	44	10·59	34	9·77	37	15·49	42
1935	16·85	40	21·56	53	20·34	40	21·93	51	17·91	58
1936	9·33	27	9·28	43	14·24	32	12·12	41	17·08	37
1937	5·14	15	8·03	34	7·23	27	9·09	36	10·67	28
1938	10·21	34	12·47	55	13·73	38	14·02	45	20·12	49
1939	12·20	40	12·66	48	12·06	42	15·69	48	15·57	53
1940	10·50	22	11·19	38	13·24	32	16·00	36	16·79	50
1941	6·39	23	9·09	34	8·59	28	9·41	33	11·16	46
1942	10·67	31	11·28	47	12·05	39	15·10	41	15·29	48
1943	12·52	28	15·87	48	14·21	39	18·40	44	21·55	54
1944	9·67	29	13·18	41	13·83	37	15·55	34	19·28	53
1945	5·36	21	6·76	35	4·22	31	8·67	30	9·79	47
1946	6·09	22	7·24	33	9·47	42	8·16	34	11·24	52
1947	9·91	37	11·60	55	11·00	52	15·85	51	15·98	65
Mean	9·71	30	11·26	44	11·92	36	14·26	38	17·32	47

TABLE 14

MOUNTAIN RAINFALL

(See text, page 115)

Period 18/8/48—3/11/49	*ins.*
Macchia, south slopes of Hogsback, c. 5300 feet	35·44
Macchia, Chatha West Ministerial Grazing, c. 4700 feet	35·06
Macchia, Mount Kemp, c. 4600 feet	29·66
Helichrysum, Wolf Plateau, c. 4800 feet	39·55
Helichrysum, north of Dontsa plantations, c. 4650 feet	30·21

RAINFALL AT NEIGHBOURING STATIONS

Period 18/8/48—3/11/49	*ins.*
Evelyn Valley	39·62
Hogsback Forest Station	39·15
Wolf Ridge Forest Station	30·36
Isidenge Forest Station	29·07
Chatha Forest Station	23·44
Lenye Forest Station	18·87
Dontsa Forest Station	15·37
Fort Cox	14·65
Rabula Forest Station	13·92
Keiskammahoek	13·67

CHAPTER 2

WOODLANDS

GENERAL

From the dry scrub which grows in the lower Keiskamma and Fish River Valleys one may proceed without a break through woody communities gradually becoming more mesophytic until they finally merge with the high forests of the Amatole Mountains, the forests in turn being in contact with the macchia on the upper mountain slopes. There is, for example, no interruption in the tree growth from the Fort Cox scrub (which includes such plants as *Euphorbia pentagona*) to the taller scrub on the west-facing slopes of Mount McDonald, the dry forest above it, and the moist macchia-bordered forests on the top of the Wolf Ridge, where *Xymalos monspora* is common; and this tree is, as stated by Sim (1907, p. 3) in his account of the Cape forests "the feature of the central damp recesses". This is confirmed by Bews (1916, p. 142; 1927, p. 15). Many similar transitions may be seen in the aerial photographs. It is not peculiar to the district and similar examples are widespread. One patch of bush on the south slopes of Stone's Hill, 4 miles east of Grahsmtown, changes from forest to dry scrub within a mile. At the upper limit of the bush in Buffelshoek, 12 miles north-east of Pearston, *Myrsine africana*, *Cassine aethiopica*, and *Gymnosporia acuminata* occur. The lower fringe contains *Carissa haematocarpa*, *Nymania capensis*, *Boscia albitrunca* and other species of the karroid broken veld (Acocks, in press). These points are brought out to show that a division of woodland into types is completely artificial. If this limitation is kept in mind, some arbitrary classification is nevertheless very convenient, accordingly the woodland in the Keiskammahoek area has been divided into seven types with the two extremes represented by Acacia scrub and macchia, and numbered from one to seven in order with increasing rainfall, as shown in the following table.

Type 1. Acacia scrub, widespread in the lowlands and abundant in the neighbourhood of Keiskammahoek Village.
Type 2. Fort Cox scrub, open, short and thorny.
Type 3. Nqhumeya scrub, taller and denser.
Type 4. Zanyokwe bush, with larger trees forming an unbroken canopy.
Type 5. Dry forest, as found at Lenye Forest Station.
Type 6. Moist forest, as found at Wolf Ridge Forest Station.
Type 7. Macchia, widespread over the highlands.

Because of the special economic importance of types 1 and 7, they have, in the pages that follow, been treated in greater detail than the others.

As the various methods of classifying woodland types have been summarised by Phillips (1928a) they need not be repeated here. Phillips himself employs the average holard as a criterion, but this method has not been used at Keiskammahoek because it is felt that there are too many objections to it. The most serious of these is the disproportionate amount of work involved in obtaining representative readings. Others are the difficulty of taking random soil samples in a forest and the fact that observations would have to extend over many years before irregularities arising from abnormal or localised climatic conditions would be smoothed out. In these studies it was found that the rainfall was a more reliable and convenient measure to use. It is a well-known fact that the water relations of the soil do not depend directly upon the amount of rain, but are bound up with a number of other matters. A good example of these is the nature of the prevailing rain, whether in the form of mists, drizzles, showers or storms. According to the form predominating, enormously different effects can be brought about, as may be realised if the Thames Valley is compared with the Bloemfontein area. The Thames Valley is well-watered and Bloemfontein is considered semi-arid, yet their average annual rainfall is very much the same in amount—25·75 and 23·5 inches respectively (van Reenen, 1923). A similar comparison has been made by Leppan (1928, p. 47). Other complications are caused by the texture of the soil, which influences the available water (Clements, 1905, p. 76), the wind, which increases transpiration (Schimper, 1903, p. 168), the plant cover, which is bound up with the run-off (Wicht, 1949, pp. 22, 34; Scott, 1949, pp. 126, 152), and the soil temperature, which may deny water to the plant even when the ground is wet (Warming and Vahl, 1909, pp. 194-5). However, most of these objections apply with equal force to the holard as well, and in practice it was found that under reasonably similar conditions of temperature and exposure a particular average annual rainfall was associated with a particular type of woodland.

With a few exceptions, the definite associations and consociations and their seral equivalents such as Phillips (1931, chap. 7) describes for the Knysna forests were not a feature of the Keiskammahoek woodlands.

In classifying the seven types, the following points were among the ones considered:—

(*a*) Rainfall;
(*b*) temperature;
(*c*) wind;
(*d*) successional stages, especially the later ones shown most clearly by the fringing species;
(*e*) trees present or absent and their frequency;
(*f*) habit and size of trees;
(*g*) definite canopy present or absent;
(*h*) associated animals;
(*i*) occurence of epiphytes;
(*j*) occurence of lianes;
(*k*) occurence of fungi;
(*l*) character and species of the undergrowth;
(*m*) limit of horizontal visibility;
(*n*) associated grasses.

The woodlands were studied firstly by making a reconnaissance of those in the district until an idea was obtained of how they might be expected to vary between the dry and the wet climates. Areas throughout were then examined in greater detail by means of general observations, and the listing (irrespective of frequency) of all the tree species observed and of the important species making up the undergrowth. This was done by crossing the area in various directions until the appearance of unrecorded species ceased more or less completely. The time taken varied from half a day to a day according to the size of the area and the luxuriance of the vegetation.

From those woodlands belonging to a particular type, one area was chosen as being the most typical representative and the composition of the trees was studied more intensively by means of belt transects, the positions of which are shown on the accompanying vegetation map. Types 1 and 7 (Acacia scrub and macchia) were omitted, firstly because their homogeneity made transecting rather pointless, and secondly because the method used for trees (types 2 to 6) could not be applied to the bushes of types 1 and 7 without giving a false picture of the communities. The areas in types 5 and 6 lie within the forest reserves and are closed to stock. The figures are not strictly comparable with those for the other types, where no protected areas were found. In the absence of any information as to the size of the sample area which would be required to give a statistically sound picture of the tree growth, an area of half an acre in each type was arbitrarily decided upon, and this was laid out across the centre of the patch. A good deal of trial and error established that 16 square yards at a time was the most that could be done, and the belt was accordingly made 4 yards wide and divided into four-yard lengths. The total length was 608 yards.

After unsuccessful attempts at marking out the transects with wire and tapes, the following method was evolved:—

Three reeds were cut to a length of 4 yards each. A starting point having been chosen, the direction of the transect was established and a reed was laid along it with its base on the starting point. The two remaining reeds were placed one at each end of the first one so as to form three sides of a square, and the position of the fourth side was judged by eye. When the square had been listed the first reed was moved forward 4 yards in the same straight line and the three sides of a fresh square were marked out, and so on until the end of the transect. Direction was maintained by compass. It was usually possible to pick up several small features like twigs, stumps and flecks of sunlight on the bearing, and by moving according to them to do without the compass except at intervals.

The counts were of the number of stems at breast height, whether they came from the same stock or not, for example a tree with a fork above breast height counted as one, but one with a fork below this level counted as two. The reason for this was that it was often impossible to establish which were unconnected stems and which were members of the same tree connected underground. The lianes in particular, at times buried and sending up branches from below the surface, gave rise to a very confusing maze of growth. Trees less than an inch in diameter at breast height were ignored. When uncertainty was felt as to the height of the taller trees, one of the reeds was used as a yardstick, otherwise the heights were judged by eye with occasional checks to correct any gradual straying that might arise. The diameters were all estimated.

Extreme boredom towards the end of the day was probably the greatest source of inaccuracy, so much so that it was found advisable to stop working on the transects in the early afternoon. For this method of doing transects three workers are needed, one to determine the species and their measurements and two to do the recording and the shifting of the reeds.

It may be seen from the summarised transect figures given in Table 31, page 74, that there is a regular increase from type 2 to type 6 only in respect of the maximum and average heights of the trees. In other characters there is the same *general* trend of an orderly increase or decrease, but with minor irregularities. The differences are what one would expect to correspond with an orderly change in rainfall.

Various methods were tried and abandoned in an attempt to make an analysis of the different kinds of undergrowth. The main difficulties were the differences in habit of the plants concerned and the great complexity and variability of the community from place to place in the same area. The only possible method under the circumstances was a written description taking into account only the points of consequence and ignoring the great mass of detail which a complete analysis should bring out, simplify and rearrange according to its importance.

TYPE No. 1—ACACIA SCRUB

"Acacia" refers to *Acacia karroo* except where otherwise stated, and may include *Acacia hirtella*, *Acacia natalitia* and *Acacia inconflagrabilis*, for the reason that the differences between them are not regarded by the writer as being of specific rank. The descriptions are to be found in the *Flora Capensis* and in a paper by Gerstner (1948). *Acacia karroo* is commonly known as "Mimosa".

THE SPREAD OF ACACIA

Places in the low-lying parts of the Keiskammahoek district are thickly covered with Acacia scrub, many being nearly valueless for grazing. The knowledge that these conditions are widespread indicated that a detailed study of this community and its relations would be of value in supplementing the work of Bews (1917a), Bayer (1933) and others. A common belief exists that such areas were once mainly grassland and that they have become overgrown comparatively recently. The following facts support this theory:—

In some areas now infested it was once so much of a rarity that farmers who wished to make brushwood stock kraals were obliged to send elsewhere for their material. Photograph 1 shows Acacia infestation on one of these farms today, the history of which is vouched for by the farmer who supplied the brushwood to its former owner.

Its rapid increase is striking on part of the Grahamstown commonage to the east of the town. Scattered over the northernmost 30 acres of the ground lying between the old and the new roads to Fort Beaufort are 29 mature trees, in height between 6 and 18 feet. The seedlings, of average height 2 feet, number just under 4400. As they have shown themselves capable of withstanding the exceptional drought of 1949, there is every reason for believing that they and their seedlings will in time densely cover the whole of this commonage. The drought referred to may be judged from the total rainfall registered at the Government Veterinary Laboratories, Grahamstown, from January to July inclusive. In 1949 it was 6·46 inches. The average for the last 15 years is 11·96.

A similar growth of seedlings in the Keiskammahoek area occurs on the slopes of the hill looking down on the Dontsa commonage from the south, that is, on the slopes north-east from point 3641. Although the younger generation is as yet only a few inches high, the growth is likewise dense. Counts indicated that there were up to seventeen to the square yard, in size from four inches down.

Pringle (1835) recorded Acacia in open formation near the source of the Baviaans River:—

> ". . . at the summit of an elevated ridge, commanding a view of the extremity of the valley . . . we beheld extending to the northward, a beautiful vale, about six or seven miles in length and varying from one to two in breadth. It appeared like a verdant basin, or *cul de sac*, surrounded on all sides by steep and sterile mountains. . . . But the bottom of the valley, through which the infant river meandered, presented a warm, pleasant and secluded aspect; . . . embellished without being encumbered, with groves of mimosa trees . . ."

Photograph 2, a view of the upper reaches of the Baviaans River, gives an idea of its appearance in 1951.

Encroachment in other parts of the country is referred to by Galpin (1926), Phillips (1930, 1935), Bews (1917a), Bayer (1933) and Scott (1949).

An apparent contradiction is provided by old postcards which include parts of the Keiskammahoek commonage and show that there was a thick growth round the town even in 1912, since when there has been only a slight increase in the particular parts which are visible. It is, however, definite that further from the town, spaces are now crowded that were clear in 1912. The photographs are not suitable for reproduction but numbers 98, 99, 264 and

265 in the files of the Botanical Survey section, Grahamstown, illustrate these facts. The inference is that round the town where grazing and trampling are more severe, the thorn scrub has more or less reached saturation point, but that it is encroaching still on the less accessible grasslands.

The evidence being thus wholly in support of an increase in Acacia, the question follows: since when has this been taking place?

Amm (1894) observed that its spread was proceeding "at an alarming rate" at Salem, and in the same year Greathead reported that a great many farms in the Fort Beaufort and surrounding districts were becoming overgrown with mimosa and "quite unfit for small stock". At Teafontein, between Grahamstown and Riebeek East, "Anti-Mimosa" (1896) regarded it, Cassandra-like, as "something to be reckoned with in the future unless prompt measures are resorted to", also as "a pest second only to prickly pear", and infestation was reported from the Somerset, Bedford, Adelaide and Fort Beaufort districts by Hobson (1896). Clear evidence of dense growth or encroachment thus goes back for 55 years, and one may safely assume that it has been troublesome for a good deal longer than this.

Bews (1917a) has shown that in Natal it is the forerunner of mixed bush, and this applies with equal force to the eastern Cape, especially on the steeper slopes and on stony ground. The significance of this will be discussed in Chapter 4. On flats, particularly where the soil is deep, and in exposed places, the Acacia tends to remain pure, at any rate for a much longer time. The Keiskammahoek postcards, by showing that there has been no influx of other species in nearly 40 years, indicate that it can be an enduring community under these conditions instead of a quickly passing phase. This point was missed by Bews, but similar behaviour is mentioned with reference to Natal in a paper by Bayer (1933, p. 281).

There are two pecularities about the unmixed and lasting Acacia thickets: firstly pure dominance is an extreme rarity in tropical and subtropical tree growth, especially in scrub (Phillips 1931, pp. 136, 169, 180; Bews, 1916, pp. 156–7), and secondly, the exclusion of other trees is not a characteristic of Acacia. As Bews (1917a) has shown, Acacia encourages their establishment. The fact that Acacia is South Africa's most widely-distributed tree (Sim, 1907, p. 212) suggests strongly that it is also the least exacting in its demands, and that it would often be the first to migrate into an unfavourable area. One could also expect to find pure and permanent stands more and more strongly marked according as the areas were progressively less suited to trees—obviously as far as these areas were not too unfavourable to preclude its growth altogether. Therefore the presence of homogeneous and stable Acacia thickets indicates, paradoxically, not an area suited to vigorous tree growth, but one where healthy grasslands might be maintained.

Bayer (1933) mentions also that in some areas of Natal, dense Acacia scrub alternates normally with grassland in the same place, and that these two communities have been replacing one another for long periods of time. So far I have been unable to find evidence for this cycle in the eastern Cape. The relationship between woodlands and grasslands is discussed in Chapter 4; here it may be stated that Acacia invasion is probably made easier if the way is cleared beforehand by the removal or weakening of the plants formerly in possession, and by a consequent lessening of competition. Dr. J. Phillips, in a personal letter, has stated his views as follows:—

"Disturbance (owing to reduced competition and higher soil moisture) accelerates the process of thicket development", and support for the statement regarding the soil moisture is given by the facts that in bare soil percolation is greater and loss of soil water less (Wicht, 1949, p. 22; Kramer, 1944, p. 545 Theron, undated, pp. 10–11, 16). Wicht's words are as follows:—

". . . if two identical areas are available—one covered with vegetation and one bare—the loss from the vegetation will be greater than from the bare ground."

The vegetation is chiefly of use in shielding the ground from the force of the direct rain, in slowing down the speed of the run-off, and in holding the soil. The last point is true particularly of grassland, of which Clements (1935, p. 356) has stated ". . . grassland binds the soil with roots as no other community does."

Contrary to popular opinion, it thus appears that bare soil may be expected to have a higher moisture content than soil covered by grass—so long as any soil remains with the increased erosion that will take place, and provided that the top soil is not so severely trampled as to become impervious.

Additionally, the work of Howard (1925, 1940) shows that grass has a harmful effect on trees because of the high proportion of carbon dioxide in the soil air beneath it. Soil air under grass has up to twice as much carbon dioxide in winter and five times as much in summer as soil air under cultivation. The carbon dioxide inhibits nitrification and the formation of humus, and interferes with the normal activities of the mycorrhiza.

It would therefore be logical to suppose that Acacia would be better able to invade a bare area, and evidence in favour of this supposition is provided by the test described in the discussion on its establishment (page 50). See also photograph 3, showing grasslands in the Bedford district, treeless except for a growth of Acacia along the roads. In this neighbourhood there are many similar examples which indicate that the grass acts almost like a protective skin which has to be ruptured before the Acacia can grow. It is of interest to note that invasion by trees after destruction of the prairie grasses has been reported also from Illinois by Woodard (1925, p. 152).

USES AND DISADVANTAGES

The tree is useful in a number of ways and its timber was once, according to Pappe (1862) "extensively employed" for building purposes. He states also that the gum exuded is of value, but inferior to that of North Africa. In this he may be wrong according to a report in *The Farmer's Weekly* (27th April 1949) that a visiting English business-man is of opinion that it may be the "finest in the world" for sweet-making. MacOwan (1890) has published a short note on the gum and its collection. Its value as a fodder tree is well known and has been recorded by Marloth (1935, p. 53) and others, but this applies more to small stock, for cattle do not browse it readily. The bark is a good source of tannin, and was much used before the exotic Acacias were cultivated in this country (Sim, 1907, p. 59). Its branches in the Border area are at the same time effective and close at hand if material is required for silt traps in the reclamation of eroded slopes or gullies, and any grass seed so caught is favoured by light shade, and protection from stock as long as the thorns remain. These areas thus have a better chance of producing a quick cover. Small shrubby forms on parts which have been mercilessly overstocked can shelter and keep alive the grass species which have vanished from the surroundings, in this way providing natural nurseries from which the grasses may spread again if the veld is protected. Older growth, however, makes such heavy demands on soil water that other vegetation may be largely destroyed, especially when the trees are in dense stands (Bayer, 1933). As a temporary fence the branches are cheap and effective and often used for enclosing pasturage or cultivated lands. In a letter to *The Farmer's Weekly*, Hermenau (1949) gives an account of having made approximately 27 miles of such fencing over 2 years. In the cleared area he has used the brush to form 74 paddocks, and has noted a great improvement to his veld in consequence of the bush clearing and controlled grazing. His paddocks are jackal-proof and, carefully made, the fences will exclude even hares. The tree also makes a "strong rough hedge" according to Sim (1907, p. 213), and its habit of coppicing would make re-establishment easy if the hedge became too open—a dense growth of young shoots is produced if the main stem is chopped off near the ground. The spreading habit of the larger specimens makes them excellent shade trees, and for shelter Acacia parkland is an asset to any farm. Its most important use by far is in providing firewood. By comparison, little else is used in the Border area, and it is interesting that Sim (1907, p. 49) records its complete disappearance from areas of the Transkei where it has been used up for firewood.

Acacias do not impoverish the soil, on the contrary their development of root nodules makes it a safe assumption that they enrich it through the addition of nitrates. Gilbert (1949) is one of the very few who takes this matter into consideration.

When the species gets out of control, the damage it causes outweighs any good it can do. It forms thickets which are for practical purposes impenetrable. Young trees on the Grahamstown commonage may be one to the square yard, and there are patches of larger trees nearly as dense at Keiskammahoek. Areas like this can be entered by stock only with difficulty or not at all, and the ground vegetation consists merely of weedy herbs. Dyer (ms.) has made some observations on the way Acacia inhibits the growth of useful vegetation. Referring to a farm in the Fort Beaufort district, he states:—

> "Mr. Malan had a cultivated field 1000 yards long adjoining a grazing camp. Mr. Malan's neighbour had removed the mimosa along the fence for about 100 yards, and, for the remainder, 900 yards of cultivated land was bordered by the mimosa growth 15 feet in height. The first point noticed was that the trees adjacent to the fence had produced the first green shoots of the season, whereas trees 30 feet away showed very little or no sign of green.
>
> On looking at the maize stalks still standing, I noticed that along the fence where Acacia had been removed the maize had flourished right to the margin of the ploughed land, whereas in a strip 30 feet wide adjacent to the Acacia practically no maize growth was to be seen. Mr. Malan stated that the roots of the mimosa penetrated easily to a distance of 30 feet into his field, and that in ploughing roots were constantly removed. This is a striking object-lesson on the detrimental effect of mimosa on the impoverishment of soil for other vegetation."

As has been pointed out, however, this effect is more likely to have been caused by competition for water than by impoverishment of the soil.

There appears to be little hope that eroded areas would ever be healed if they remained under Acacia. The work of Bayer (1933) shows that conditions in such areas become progressively worse. Bad cases are illustrated in the pamphlet by Pentz (1938, photographs 4 and 5), and in *The Farmer's Weekly* (27th July 1949, p. 52). As will be shown later, it is not likely to prove a nuisance in the lower rainfall areas. In criticising Hobson (1896a) for advising the planting of this tree in the Graaff Reinet district, "Anti mimosa" (1896) was judging from his own area, Riebeek East, which has a rainfall of over 20 inches.

DISTRIBUTION AND LIMITING FACTORS

In Africa as a whole, the genus Acacia comprises easily more trees than any other. The area now dominated by it is immense, its relations to grasslands a continental problem of the greatest importance. Rose-Innes, in a personal communication, says:—

> "It starts down in the coastal belt, stretches up along the east coast with several excursions into the interior, then it is found on both coasts and goes on north (with the exception of the equatorial forest section)

right to the boundary of the Sahara in the west (I saw lots of it on the coast at Cape Verde), and on into Abyssinia and beyond in the east."

Bews stresses this point in his paper on the succession in the thornveld of Natal (1917a).

Acacia karroo provides a good foundation for study because it is South Africa's most southerly representative of the genus; thus at the limit of its range southward one may begin by watching one species without being confused by the behaviour of a mixture of close allies. In addition, its foothold is likely to be precarious, so that slight changes in the habitat should influence it far more strongly than equal changes further north—for example, where it is barely able to exist in a dry area, a decrease of a few inches in the annual rainfall would probably be fatal. Where there is moisture and to spare this decrease would not be significant. The large number of climatic regions in the eastern Cape and the Cape Midlands is shown in the paper by Schulze (1947)—such conditions yield information more easily than regions with an even climate (Schimper, 1903, p. 451).

Sim (1907, p. 212) states that it is South Africa's most widely-distributed tree, extending from Cape Town northward and eastward. In spite of its tropical affinities, it is not a recent introduction in the southern part of the continent. It has been calculated that a specimen in Parliament House grounds, Cape Town, germinated in about 1572 (Hutchins, 1892, p. 180). Sim also mentions that it extends up to an altitude of 4000 feet from the eastern coast and "considerably further from the west". This last statement, however, is too sweeping, and applies only to the country north of the Orange River, where it is found as far east as the main road from Bloemfontein to Johannesburg, the altitude of which is about 4500 feet. Instances will be given to show that it does not extend so high south of this area. In the Keiskammahoek district the Acacia occurs mainly below 2500 feet, in thickets on the commonage round the town and on the more gentle slopes at Lenye Forest Station, and peters out at about 3500 feet.

Sim (1907, p. 212) writes: "Its range is however curiously affected in places, being absent, possibly through frost, in several large flat alluvial localities where single trees have grown to perfection", and again, of east Pondoland (1900, p. 200), he writes: "The common mimosa is here, as elsewhere, most erratic in its distribution."

But if one disregards these many small irregularities, one finds that its boundaries are fairly clearly defined, and this being so it should be possible to find its limiting factors with reasonable accuracy. In the field it is impossible to deduce with certainty the influence of a particular factor. Acting as a whole, they are so closely linked that a change in any one upsets the balance between them all. Other things being equal, a change for instance in the holard affects soil temperature (Beadle, 1940, p. 184) and aeration (Kramer, 1944, p. 525), a change in air temperature is related to evaporation (Leighly, 1937) and soil temperature (Aitken, 1922, p. 214), and these in their turn act on other factors so that the whole environment is changed. In a general survey one is thus forced to regard mainly those factors strong enough to overwhelm their subsidiary influences. Although there are dissentients and exceptions (Beadle, 1951), it has been generally accepted since Schimper's time that the climate has the greatest influence on plants, and that of the climatic factors moisture and temperature are the most important. Schimper (1903, p. 160) states that the type of *vegetation* is determined by the moisture and the type of *flora* by the temperature—in other words that the rainfall and the presence or absence of desiccation will determine the growth of trees, grass or desert, and that the temperature will determine what particular species are present in each formation—and observations of ecologists in all parts of the world indicate that this concept is sound (see Dansereau, 1951, pp. 193–4).

The main possibilities therefore for its absence from parts of the Cape Province are:—

(*a*) Excess moisture;
(*b*) dryness;
(*c*) low temperatures;
(*d*) high temperatures.

To these possibilities the following arguments may be applied:—

A. ABSENCE CAUSED BY EXCESS MOISTURE

For

1. Acacia is found at Queenstown where the annual rainfall is 20 inches (Irrigation Department *Rainfall Map*, 1939), and is absent from 24 miles north of Queenstown to Aliwal North and beyond, where the rainfall is from 20 to 25 inches.

Against

1. It grows freely on the road from Port St. Johns to Lusikisiki, which is above the 45-inch isohyet and has a humid climate (Schulze, 1947).

2. Trees thrive at the intakes to dams and in the seepage areas below them.

Conclusions

It is not limited by excess moisture, as far as 45 inches of rain at least.

B. ABSENCE CAUSED BY DRYNESS

For

1. Although absent from the veld generally, in karroid areas it will grow in depressions and watercourses where additional moisture collects. This fact was noticed by the earliest travellers as the following passage from Barrow shows (Barrow, 1806, Vol. 1, p. 48). Of the country about 15 miles north of the Swartberg, that is 30 or 40 miles north of where Calitzdorp is to-day, he writes:—

> "Though the surrounding country was destitute of vegetation, a thick forest of mimosas covered the banks of the Dwyka, and followed it through all its windings. This plant grows indeed on every part of the desert, of which it is the inseparable companion of all the rivers and all the periodical streamlets."

The region mentioned has a rainfall of under 5 inches. This relationship, mentioned also by Schimper (1903, p. 630), may be seen to-day in any watercourse of the Great Karroo or the Fish River Valley.

2. Towards the 15-inch isohyet it will grow also along the margins of the roads. Counts have been made near Fort Brown on the road between Grahamstown and Fort Beaufort (see Table 15), and the scattered fringing trees are a feature of parts of the road between Pearston and Graaff Reinet. The rainfall is between 10 and 15 inches in both areas. A possible explanation of this is that the slight run-off from the hard and cambered road finds its way to the edges, and there provides the extra moisture needed for the establishment of the seedlings.

Because Acacia is absent from the roadsides in the area mentioned by Barrow (as is noticeable along the national road between Laingsburg and Prince Albert Road) one may assume that towards the 5-inch isohyet the extra moisture provided from even macadamised roads is not enough to support it.

3. With increasing rainfall it is able to move out from the favourable areas and invade others, less favourable, in the vicinity. Its place along the stream banks is then taken over more and more by different trees, very commonly *Combretum salicifolium* and *Salix capensis* in that order. The riverine vegetation is a reliable indicator of conditions in the sur-

TABLE 15

INCIDENCE OF *ACACIA KARROO* IN DISTURBED AND UNDISTURBED VELD, FORT BROWN

Belt Transect Figures, in Sections of 12× 12 yds.

Margin of Road (Disturbed)	*Adjoining Veld (Undisturbed*
7	0
1	0
1	0
4	2
5	2
1	3
2	3
4	2
5	2
2	0
2	2
9	2
6	0
4	1
1	1
1	2
3	2
1	1
3	0
6	1
3	3
6	6
5	1
6	2
7	0
5	0
3	1
8	2
4	0
1	0
1	0
0	0
6	2
9	3
8	0
2	0
2	0
1	0
1	0
0	1
0	0
2	1
10	1
6	0
1	0
6	0
8	0
25	0
7	0
9	1
2	2
8	0
17	0
1	3
2	2
7	1
5	1
2	0
5	3
2	0
1	0
1	0
4	1
7	6
284	69

rounding country, and can often provide a clue when these conditions have been masked by overstocking. The change from Acacia to Combretum and Salix takes place in a rainfall of between 15 and 20 inches. Below this point the country is the Karroid Veld of the eastern Cape (Acocks, in press), and in such areas grass pastures are maintained with a certain amount of difficulty and overgrazing tends to bring in not pioneer grasses but karroo bushes (Dyer, 1937, p. 87). Above this point Themeda pastures or mixed scrub of a more mesophytic character is the rule. Here the grass cover is more easily maintained in some form or another and karroo bushes make their appearance only after prolonged overgrazing. An example of this is to be seen on the road from Grahamstown to Bedford about 12 miles north of Carlisle Bridge where there is a fork for Adelaide in country which is now covered with karroo bush, and has its gullies fringed with Acacia. The change to moister conditions, where karroo bush is absent, and where Acacia can grow away from the gullies, is clearly visible 9 miles from the fork on the way to Adelaide.

It may be legitimately asked why Acacia, which can stand 45 inches of rain in a humid climate, does not continue along the streams even where it is able to exist away from them. The reason is that improved water supplies make it possible for the more mesophytic and broader-leafed trees to establish themselves, and the effect of their deeper shade is unfavourable to the growth of Acacia. If for any reason the invasion by shade trees is delayed or prevented, the Acacia remains, and this may be seen along the Jukskei River north of Johannesburg, where the rainfall is 25 inches. Acacia trees in the deep shade of forest margins are barely able to live in a weakened and divaricate form, as is shown in parts of the Lenye Forest Station, Keiskammahoek, and they are "always absent from high forest" (Sim, 1907, p. 4). This fact is supported by the observations of Bews (1917a, p. 157).

An interesting fact is that Acacia is absent from the whole of the Knysna region with the exception of two small isolated patches (Phillips, 1931, pp. 142, 162), and it is a strong probability that shade is the force responsible for excluding it so effectually from this area of climax high forest—not only the largest in the Union but one extending formerly over a much wider area (Phillips, 1931, p. 233).

4. Acacia growing in damp situations develops into a fine shady tree with a clean bole and few thorns, but on shallow soil, especially in exposed places, and in dry situations, it becomes a gnarled bush, branching, thorny and stunted. Such trees remain so permanently, and can not be regarded as merely juvenile forms which, having lately invaded the area, are still to grow. If this were so, one would expect to find at least some large trees under dry conditions, but this is never so. Additional evidence is given by photographs taken in 1912 or thereabout by Mr. W. M. Spring, showing the drier parts of the Keiskammahoek commonage with the small trees described—an examination of the same area in 1949 established that for the trees as a whole there had been no perceptible increase in size during the past 37 years. The response to moisture was noticed by Lichtenstein round a spring known as the Hofmansgat, near Assegai Bush, between 1803 and 1806. Concerning the mimosa, he writes:—

> "In the karroo these trees have the form only of large shrubs, branches coming up from the very roots, which are fast enclosed in the earth: here they have stems 8 or 10 feet high before any branches are thrown out."

Against

There appear to be no valid arguments against this theory.

Conclusions

These data show that there is with decreasing rainfall a limit beyond which the species cannot normally exist, and that it may be expected to disappear from the landscape in general between the 20-inch and the 15-inch isohyets.

ABSENCE CAUSED BY LOW TEMPERATURES

For

1. Acacia trees cease at the following clearly-defined points, although they are common from these points into regions of lower altitude:—

(*a*) Main road between Bedford and Tarkastad, south of de Beer's Pass at Cheviot Fells, altitude 4500 feet;
(*b*) 7 miles from Toise River on Henderson road, altitude 3500 feet;
(*c*) 7 miles from Cathcart on Henderson road, altitude 3500 feet;
(*d*) 3 miles from Cathcart on Queenstown road, altitude 3500 feet;
(*e*) 7 miles from Happy Valley on Cathcart road, altitude 4000 feet;
(*f*) Post Retief Post Office, altitude 4000 feet;
(*g*) main road between Adelaide and Tarkastad, 4 miles north of fork to Glenthorn, altitude 4000 feet.

As it has been established that the temperature drops with increasing altitude (Sim, 1907, p. 38; Schimper, 1903, p. 701), it is possible that its spread is stopped beyond these points by the greater cold. It may be argued that it is still on the move and may yet cross these limits, but the facts which follow militate against this possibility. Firstly, the altitude is fairly uniform. Secondly, Pringle (1825, p. 34) reported of the headwaters of the Baviaans River: "We found the valley sprinkled over, as has already been noticed, except at the extremities of its subsidiary cleughs, with fine clumps and groves of mimosa trees, interspersed with open grassy pastures . . ." Cheviot Fells (see paragraph 1a) is in this immediate vicinity, which means that the altitudinal boundary was substantially the same 120 years ago.

2. Clements (1934, p. 48) has shown that under conditions of drought the mesophytic trees drop out in order on the following aspects:—

south-west
south
south-east
north-east.

In other words, these aspects have in order less extreme conditions. In the southern hemisphere the corresponding aspects are:—

north-west
north
north-east
south-east.

These deductions are naturally not to be taken at their face value, for conditions may be different in the eastern Cape because of localised conditions like rain shadows and the nearness of the sea. Field observations, however, have shown that they do hold true. A good example is to be found on Round Hill (see page 104). It is a regularly-shaped hill and isolated. Its southern slopes support mixed bush, including such genera as Pittosporum, Pterocelastrus, Pleurostylia and Cassine, and it will be shown later that this bush is more mesophytic than the clumps of Acacia which are the only trees on the slopes facing north (see photographs 4 and 5). In addition, these are stunted by comparison with the few individuals found on the south side where clear spaces provide the sunlight necessary for them to grow. The more detailed relationships of climate and aspect may be inferred from the meteorological observations from the

Keiskammahoek district. At all five stations the temperatures were found to increase through the morning to their maximum round 2 p.m. (see Figure 3), thus it is the north-west slopes which receive the direct sunshine during the hottest part of the day, the north-east ones receiving it when the temperature is mild, with the north slopes intermediate.

These observations, and the work of Aitken (1922) and Potzger (1939) indicate why it is that towards its altitudinal limits Acacia drops out on the south-facing slopes first—they are the colder ones and are therefore less favourable to it. So far no exceptions have been found to this rule. The difference between its limits on south and north slopes can be seen without difficulty for it amounts to several hundred feet. Good examples occur at points (*a*) and (*g*) tabulated on page 35.

3. Twenty-four miles from Queenstown on the road to Aliwal North the slopes face east and west, and, as might be expected, the trees drop out first on the east-facing slopes.

4. Temperature data for the Union as a whole on a more general basis are given in the bulletin published by the Meteorological Office (1942) and printed by the Government Printer, Pretoria. Acacia is absent from a large area of the Union, corresponding closely to the region of mean absolute minimum temperature for July of 20°F and below, and shown in Figure 4. The data in this bulletin, with minor differences according to the way in which they are expressed, agree in showing this region to be the coldest in the country. As Schimper (1903, p. 417) has shown, an *exact* correlation between temperature and vegetation is impossible, but the *general* correspondence in this case is striking, particularly in the example given. The minimum is chosen for an illustration because it is the extremes of factors which have the main influence on the vegetation rather than the average (Cox, 1933, p. 316; Balchin and Pye, 1950, pp. 345, 347). An example from Kendrew (1922) clearly illustrates how the two may differ: Pekin and the Scilly Islands have almost the same mean temperature, yet the monthly means range respectively from 79° to 23° and 61° to 43°.

Against

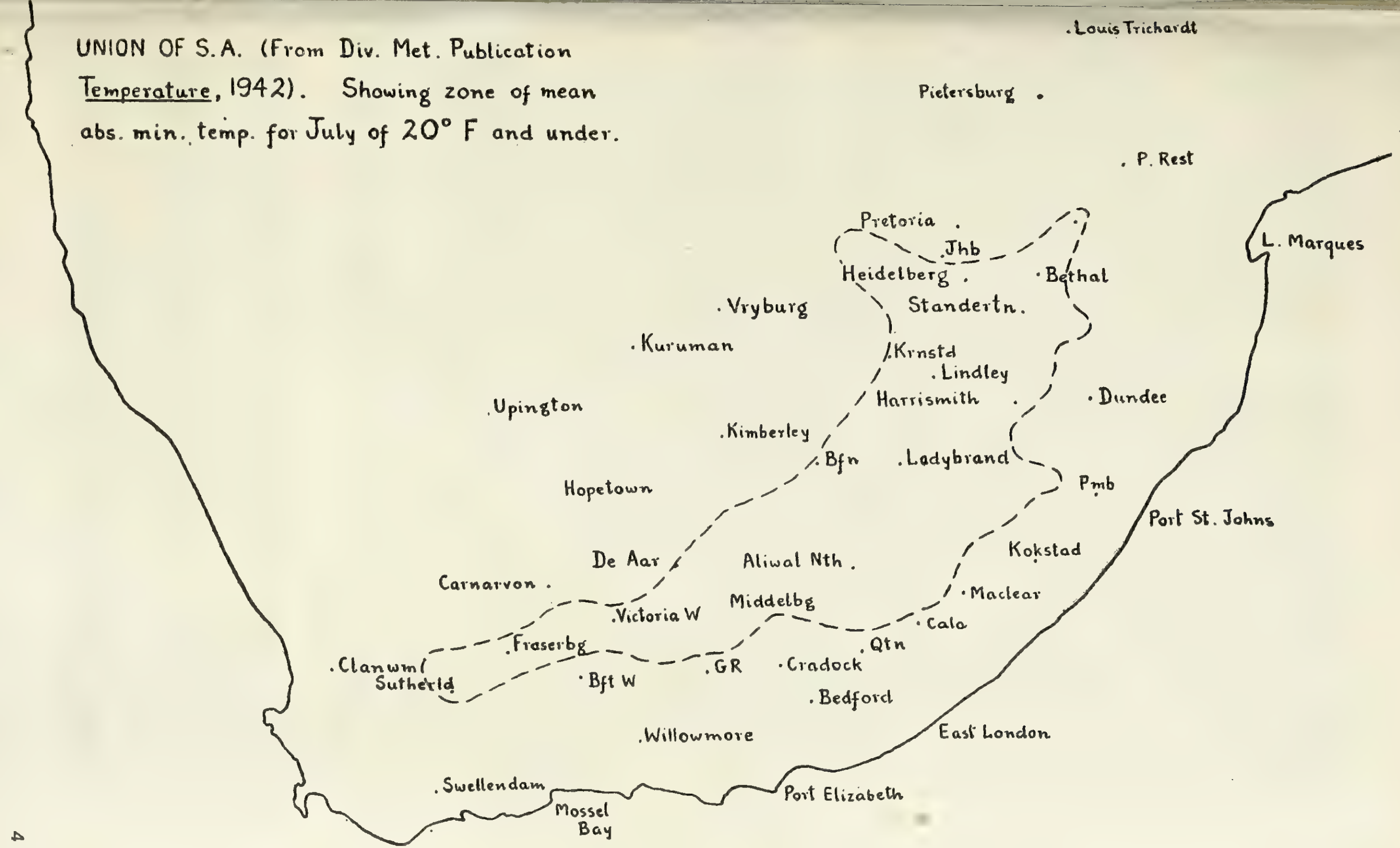
1. Acacia is able to exist even where snowfalls are experienced. They occur at Queenstown, which is notorious for its Acacia encroachment, and Acacia trees have been seen under snow near Indwe. However, the presence of snow does not necessarily indicate an extremely cold area even if judged by South African standards. Both the examples given lie outside the cold region shown in Figure 4, and the objection therefore does not appear to be a serious one.

2. Many authors, Sim (1907), Bews (1917b) and Schelpe (1946) among those in South Africa, have discussed the drop in temperature which goes with increasing altitude. The drop is apparent from the fact that mountains sufficiently high will reach the line of perpetual snow, wherever they may be situated. Most authors mention also that during the night the cold dense air on the mountain tops sinks down into the valleys, and that warmer air may take its place. If this happens, the normal relation of temperature and altitude is reversed, a state of affairs known as "temperature inversion". From this they conclude that the heaviest frosts at night will be in the valleys, and confirmation is to be found in papers by the Meteorological Office (1942) and by Whitmore (1949a).

The Meteorological Office pamphlet, Chapter 5, p. 7, states:—

> "It is common knowledge that frost occurs more readily and more heavily at the lowest point of a valley than on the slopes (especially on the northern side) of a range of hills or mountains."

With respect to frost-free areas, Whitmore recommends the upper



UNION OF S.A. (From Div. Met. Publication Temperature, 1942). Showing zone of mean abs. min. temp. for July of 20° F and under.

Fig. 4

and middle slopes of hills as being the safest. In all these papers, however, there is an awkward lack of comment on a difficulty which arises with respect to a *high* mountain. Kilimanjaro may be chosen as an example for the purpose of illustration. The top is well above the perpetual snow line and the base is frost-free, but the papers cited, taken at face value, would lead one logically to the wrong conclusion that there would be heavier night frosts at the foot than above the snow line.

The following is an extract from a letter which was written in this connection to the Director of the Division of Meteorology:—

> "I should be glad of your comments on the following aspects of temperature. The general rule is that temperature decreases with altitude. At night, however, the heights cool more rapidly than the valleys, and the resulting high cold air drains downwards so that the heaviest frosts occur in the lowest parts—this you have explained in your pamphlet on temperature. Yet I feel that this is not the whole story, as the highest mountains experience the most severe frosts. Postulating an ideal mountain slope (that is, without irregularities), could one expect to find on it a point which would be warmer at night than both the top and the base? The absolute minimum temperatures are important from the vegetational point of view. Regarding them, is there some general rule by which one may know for any particular place which of the two contradictory factors—cold air drainage and altitude—is the determining one?"

I am indebted to the Director for the following reply:—

> "In reply to your Minute M 19 of the 27th ultimo I wish to point out that the general rule that air temperature decreases with altitude applies to the free atmosphere. The presence of a land mass, whether with an ideal slope or not, complicates matters to such an extent that no simple rules can be derived for the variation of night temperature with altitude at the surface of a mountain slope."

Although the presence at night of a warmer zone sandwiched between two colder ones cannot be predicted with certainty, there is some evidence for its existence, for Sim (1926, p. 494) refers to:—

> ". . . a native's frost-free garden at about 7000 or 8000 feet altitude, while the river was frozen over in the valley below, and snow was on the berg above."

To sum up, mountains are in general cooler than the lowlands, but because of the complicating influence of cold air drainage and because of a possible warm zone somewhere on the slopes, the evidence given in paragraph 1 cannot be regarded as entirely conclusive.

D. ABSENCE CAUSED BY HIGH TEMPERATURES

For

1. Burtt Davy and Hoyle (1936) do not record *Acacia karroo* from Tanganyika or Kenya, which, being in the tropics, are in general hotter than southern Africa.

Against

1. It grows in the low country of the eastern border of the Kruger National Park, which the temperature map shows to be the hottest part of the Union.
2. Marloth (1925) mentions its occurrence as far north as "southern tropical Africa". This agrees with the publications of Baker (1926) and Burtt Davy and Hoyle (1936), both of which record it from Nyasaland.

Conclusions

There is a possibility that the high temperatures of the equatorial regions are unfavourable to it, but heat does not limit its distribution in South Africa.

GENERAL CONCLUSIONS

The evidence is that dryness and cold each limit its spread, but that it can stand a great deal of heat. Sim's observations (1907, p. 212) are in support of this:—

> "Although usually evergreen, yet in dry cold carroid localities it is often leafless for years in succession, and is then enormously spiny and colours the veld white instead of green."

Spininess and the shedding of leaves are reactions to dryness (Rawitscher, 1948, p. 258; Schimper, 1903, p. 17); their presence as described by Sim is an abnormal feature of this tree, and shows that it is out of its true habitat.

Bews (1917b, p. 542) suggests that Acacias are absent from the greater altitudes because of the lack of lime in the soil, and common in the valleys where it is plentiful. That this is more likely to be a reaction to temperature is indicated by the Acacia thickets in some of the country lying about 15 miles north of Johannesburg, notwithstanding the fact that the soil is derived from granite and is accordingly highly acid, with pH values of about 5·5 (Meredith, 1947, p. 73). Potts and Tidmarsh (1937, p. 74) have also observed communities of Acacia growing in a soil which continued to show an acid reaction down to 3 feet. A second point is that *Acacia karroo*, although present in abundance in alluvial soil in the Riversdale district, is absent from limestone ridges (Muir, 1929, pp. 31, 37). Probably therefore the pH of the soil is a matter of indifference to it. Observations show that it is undiscriminating as to soils. Although Muir (1929, p. 33) reports that it is not found on the sandveld of the Riversdale district, it has been noticed growing well on sand 20 miles from Hoopstad on the Bothaville road and (together with mixed scrub) round the town of Bothaville itself. Its absence from the Standerton district might argue that the heavy turf soils of that part are unfavourable to it, were it not for its healthy growth in the black turf of the Springbok Flats. It can grow on the deepest alluvial soils (Muir, 1929, p. 37) and on shallow soils overlying the bed rock.

NATURAL ENEMIES

Confirmation from many sources can be found for Sim's statement (1907, p. 212) that it is the host of "an innumerable lot of pests". In the Keiskammahoek area it is attacked by a bagworm, probably the wattle bagworm, reported as a parasite on this tree by Henkel (1932). Another important parasite which has been noticed here and there is *Prosopophora prosopidis* var. *mimosae*, a scale insect causing great destruction to the Acacia at certain times, but having peak periods alternating with others during which it dies out through some unknown cause. E.W. (1896) writes as follows:—

> "About twenty years ago this scale visited the Kowie valley, between Bedford and Adelaide, entirely destroying the thorn trees in the course of two years. It then disappeared altogether until last year, when it made its appearance again and now the same glorious work of destruction is going on."

The insect has been studied by Lounsbury (1896 and 1898), who states that it may be encouraged to invade areas by tying infected twigs to healthy trees towards the end of December, which is the time the eggs are laid. The newly-hatched insects make their way off the infected twigs and distribute themselves over the tree, but it is only the youngest stages which can move about, and it is consequently useless to try this method at any other season.

Besides the destruction of green pods by the Longicorn and Lamellicorn beetles, there is destruction of the ripe seeds by *Nariscus cinctiventris*, which is described by Stal (1864). The insect is common near the Acacia trees and may be seen attacking the seeds on the ground by puncturing them with its proboscis. This is hairlike, flexible and half an inch long, but nevertheless goes through the extremely hard testa, and the insect may be lifted up with the seed hanging from the mouth parts. By far the most important destroyers of seed, however, are the weevils, the species concerned probably being *Bruchus rufulus.* These insects lay their eggs on the seeds after the pods have split open, and the larvae as they feed will readily destroy an embryo lying in their path (Skaife, 1926, p. 579). A study of infestation in Acacia seeds gave the results shown in Table 16.

Germination is very poor in infested seed—8 per cent—while normal germination may be as high as 95 per cent. Normally, infested seeds produce only one insect each, but very rarely two insects may emerge from a single seed. Some other species also have this peculiarity, for example *Bruchus pisorum*, and the reason for the early death of all but one in each seed is not yet understood (Brain, 1929). Among other insects noticed emerging from the seeds were tiny wasps (Chalcids), which were comparatively scarce. Their larvae were not parasitic upon the weevil as one might suppose, but were also vegetarian. As the seeds from which they are hatched show a slightly higher germination (24 per cent), these wasps are probably too small to do as much damage to the seeds as the weevil. They may attack the green seeds while they are still in the pod, in which case they give rise to galls on the seeds.

There are many other parasites of varying importance which have not yet been studied.

PROPAGATION

Flowering and Seeding

There is a great variation in the gross yield of flowers from year to year in any one area, and the yield of individual trees is also irregular. The flowers are borne on the periphery of the trees, which begin coming into bloom when about 3 feet high. Although a few flowers may be found in October, the time of their abundance is from February to April and varies with the weather. Flowering may continue in a small way for several months on one tree, until flowers and the same season's ripe seed occur on it together. Occasional trees will bear out-of-season flowers even in the middle of winter, and these will produce seeds if the weather is mild. The mortality from insects, mainly Longicorn and Lamellicorn, is often high, and a dry hot spell may destroy most of the yield and cause a heavy fall of shrivelled brown flowers below the trees. There are about 70 flowers to a head, and from counts done in 1948 it was established that about 1,120,000 flowers (16,000 heads) gave rise to 3200 pods—a flowering efficiency in these particular examples at least of 0·3 per cent. The average number of seeds to a pod was 6·70. One of the larger trees examined (which appeared to be bearing a normal crop) produced 2800 pods; its seeds were probably in the neighbourhood of 19,000. Seeds from different localities vary greatly in colour and size—there may be from 560 to 1030 to the ounce.

The pods, from one to seventeen to a peduncle, are curved and vary in length between 1 and 2 inches. They are slightly constricted between each seed, which thus lies in a compartment of its own. Usually they dehisce down their length when ripe without falling from the peducle and without shedding their seeds. Alternate seeds are attached to the same half of the pod, and to its inner curve, by a quarter-inch curly funicle. The hilum faces away from the pedicel. Although both Marloth (1925, Vol. 2, Section 1, Plate 18) and Sim (1907, Plate 61) show adjacent seeds in the same half of the pod, all the evidence so far seen indicates that their drawings are incorrect regarding this detail. Pods begin forming towards the end of February and are ripe in the middle of May as a general rule, but the ripening is irregular, and pods of different ages may be found even on the same peduncle. Some of the pedicels and funicles

Table 16

WEEVIL AND WASP INFESTATION IN ACACIA SEED

Sample No.	Where Collected	When Collected	Total Seeds	Infested 25/9/47	Infested 14/10/47	Infested 12/11/47	Infested 19/2/48	Total Infested	Per Cent
2592	Ft. Beaufort	15/6/47	374	7	54	119	5	185	49
2597	Cradock	25/6/47	1,160	16	11	41	4	72	6
2598	Bedford	25/6/47	1,314	35	4	18	5	62	4
2601	Albany	27/6/47	1,473	117	110	74	0	301	20
2623	Uitenhage	28/6/47	322	13	2	1	0	16	5
2702	Ft. Beaufort	20/7/47	12,499	1,485	460	885	81	2,911	23
2705	Estcourt	—/7/47	4,112	257	106	1,588	25	1,976	48
3142	Pretoria	26/8/47	2,442	222	0	0	2	224	9

Total: 23,696 seeds, 5747 infested = 24 per cent.

are resistant enough to allow the seeds to remain on the tree until those of the next season are ripe, and winds even of force 7 on the Beaufort scale will dislodge only part of the crop. By these means, a well-distributed fall of seed is obtained instead of a heavy fall at one time.

Since the reproductive cycle is as a rule completed within the first 5 months of the year, it might be expected that good rains during this period would bring on profuse flowering and seeding, but two years' observations indicate that this is not necessarily so. The rainfall from January to May inclusive was 13·17 inches in 1948 and 6·40 inches in 1949. Of the trees examined, the yield was at least twelve times greater in the drier season, as shown in the following table:—

TABLE 17

APPROXIMATE NUMBERS OF FLOWERS AND SEEDS

Tree No.	21st May 1948	31st March 1949
1 . .	139 pods, no flowers	1000 pods, 500 flowers
2 . .	6 ,, ,,	400 ,, 0 ,,
3 . .	8 ,, ,,	500 ,, 0 ,,
4 . .	0 ,, ,,	120 ,, 0 ,,
5 . .	0 ,, ,,	300 ,, 150 ,,
6 . .	11 ,, ,,	0 ,, 0 ,,
7 . .	200 ,, ,,	100 ,, 100 ,,
8 . .	0 ,, ,,	10 ,, 20 ,,
9 . .	0 ,, ,,	500 ,, 50 ,,
10 . .	0 ,, ,,	34 ,, 400 ,,
11 . .	0 ,, ,,	500 ,, 0 ,,
12 . .	0 ,, ,,	34 ,, 400 ,,
13 . .	0 ,, ,,	200 ,, 200 ,,
	364 pods, no flowers	4364 pods, 1820 flowers

It has been noticed also that along the water-courses in the Fish River Valley there is a tendency for the trees to bear more prolifically the further they are from the water-course. A possible explanation is the general one given by Schimper (1903, p. 26):—

> "The production of sexual organs is usually impeded by a considerable supply of moisture and favoured by drought."

Phillips also (1931, p. 247), referring to indigenous trees in the Knysna forests, states that strong light, disease, damage, burning—in other words extreme conditions—cause more abundant flowering. Confirmation is to be found in the editorial notes of the *Empire Forestry Review* (March, 1951, p. 15), where it is mentioned that "ill-treatment of fruit trees in making them produce more fruit dates from very ancient times", and that the practice has recently been applied experimentally to forest trees in the United States.

SEED DISPERSAL

Seed dispersal was first investigated on the Grahamstown Commonage East. The area is for practical purposes level, and is covered with a uniform and closely grazed turf of *Themeda triandra*. Apart from scattered individuals, the trees are concentrated into thickets about 20 yards in diameter, with their perimeters fairly clearly defined. As the thickets do not coincide with dips, rises or old disturbed areas which could possibly account for their patchiness, the reason for this peculiar distribution is at first puzzling. Some of these thickets are found with a large tree growing close beside them, a relationship common enough to suggest the possibility that the large tree is the parent. It is never in the centre of the clump but always at the edge and always on the western edge. This in turn suggests wind dispersal—not from moderate winds, which would hardly be capable of transporting seeds so little adapted to it, and which in addition come from any quarter, but from strong winds. There are no satisfactory data as to their force and direction as Dyer (1937, p. 54) has pointed out, but a clue is given by two lines of telegraph poles running across the area. Except every tenth one, which is anchored, they are all inclined away from the perpendicular in one direction. Having been found by means of a plumb bob for 20 unanchored poles, the direction of greatest slant was measured by compass and gave an average magnetic bearing of 133 degrees. From 12 parent trees the magnetic bearings through the centres of the corresponding patches of seedlings averaged 126 degrees. Details are given in Table 18. It is felt that this very close correlation establishes the direction of the prevailing winds and establishes that these are the main agents of distribution. As they travel at a magnetic bearing of 130 degrees (between 133 and 126) they blow from the back bearing, that is 310 degrees. Corrected to the true bearing, this is 290 degrees, or west-north-west. This supports Dyer's observation that these strong winds are mainly from the north-west.

TABLE 18

DIRECTION OF STRONG WINDS AS SHOWN BY TELEGRAPH POLES

GRAHAMSTOWN COMMONAGE

Pole No.	*Direction of Slant*
1	95
2	140
3	125
4	120
5	131
6	150
7	150
8	137
9	146
10	110
11	134
12	135
13	155
14	128
15	148
16	134
17	145
18	118
19	122
20	141
	2664

Average = 133 degrees magnetic
= 113 degrees true
Back bearing = 113+180 degrees
= 293 degrees
Prevailing strong winds from 293 *degrees*

GROUPING OF ACACIA SEEDLINGS WITH RESPECT TO PARENT TREE

GRAHAMSTOWN COMMONAGE

Tree No.	*Bearing of Seedlings from Parent Tree*
1	145
2	123
3	125
4	115
5	132
6	115
7	130
8	125
9	129
10	115
11	130
12	130
	1514

Average = 126 magnetic
= 106 true
Back bearing = 106+180 degrees
= 286 degrees
Bearing of parent tree from seedlings 286 *degrees*

As a further check on wind dispersal, the commonage was visited on the afternoon of 21st June 1949, when the first strong wind of the season had been blowing since the morning. The wind was coming from the true west, the force 7 according to the Beaufort scale, and to leeward of the seeding trees the freshly fallen pods and seeds were numerous, ranging from 8 to 32 to the square yard, with an average of over 20. Some seeds were attached to the open pods, others were still completely enclosed and the rest were free. Even in this strong wind, which was obviously well capable of blowing such things for great distances, the pods were found to be caught up in the short grass close at hand and to correspond very nearly with the area occupied by the seedlings. In all, strong winds on the commonage were checked five times, with the closely similar results given in Table 19.

TABLE 19

DIRECTION OF STRONG WINDS BY OBSERVATION

GRAHAMSTOWN COMMONAGE

Date	*Force*	*Bearing into Wind*
21/6/49	7	290
23/6/49	6	335
11/7/49	7	315
18/7/49	7	330
5/9/49	6	280
		1550

Average = 310 magnetic
= 290 true

Prevailing strong winds from 290 *degrees*

These facts still do not account for the many patches of young trees which have no parent tree near them, but traces of the parent were found nearly always. Sometimes the stump was still to be seen, sometimes its former position was shown by the presence of a cushion of cropped scrub pioneers like *Scutia myrtina*, *Gymnosporia buxifolia* and *Carissa bispinosa*. At times all that remained was a hollow about 12 feet across. Such hollows are often found round the stems of the large trees and are caused by the trampling of cattle which come together under their shade. It remains long after the tree has vanished (see photographs 6 and 7). It was possible to confirm this by digging down into the centre of the hollow and finding the cortex of the roots still preserved, lining the inner surface of a system of radiating tunnels, the vascular tissues having rotted away, leaving the tunnels clear inside.

Dispersal by water probably takes place only during storms, for the seeds are heavier than water. In the lower parts of the Fish River Valley, where the trees line the watercourses, this is an important means of dispersal as is shown by the many seedlings which come up in the sandy beds. The trees play a useful part in such areas in catching rubbish and checking erosion.

Grazing animals do not transport the seed to any extent in the Grahamstown area. If they did, it would be shown by the presence of seedlings in their droppings but this has never been observed. Although cattle congregate under pines and gums and in natural bush clumps on the commonage, there are no Acacia seedlings under such trees or near them. This fact is probably because there are relatively few seeds produced over the commonage and when the hundreds of established small trees come into bearing and yield plenty of seeds within easy reach of cattle, the results are likely to be very different. Browsing cattle normally do ingest seeds, some at least of which are able to pass through the animal and remain viable. Mr. C. J. Skead, of Gameston, Albany, has been able to collect seed from their droppings, and ten seeds were tested in the laboratory in September 1947. Six germinated at times varying from the fifth to the 117th day. The long period of dormancy of some of these shows that the testa can withstand digestion and yet remain highly impermeable. Seeds germinated in dung in the laboratory to check the possibility that it might be an unsuitable medium for them, established themselves without

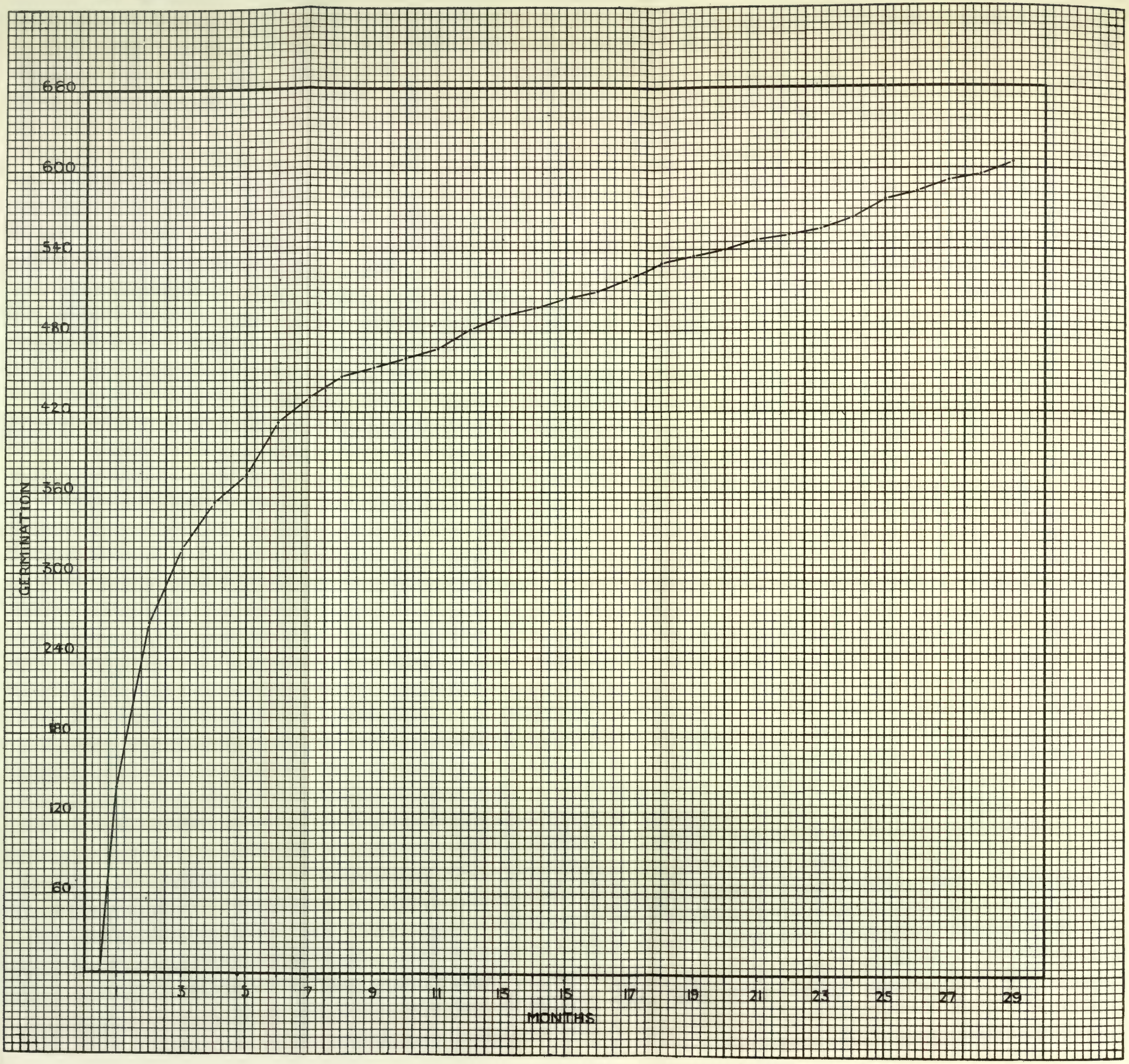
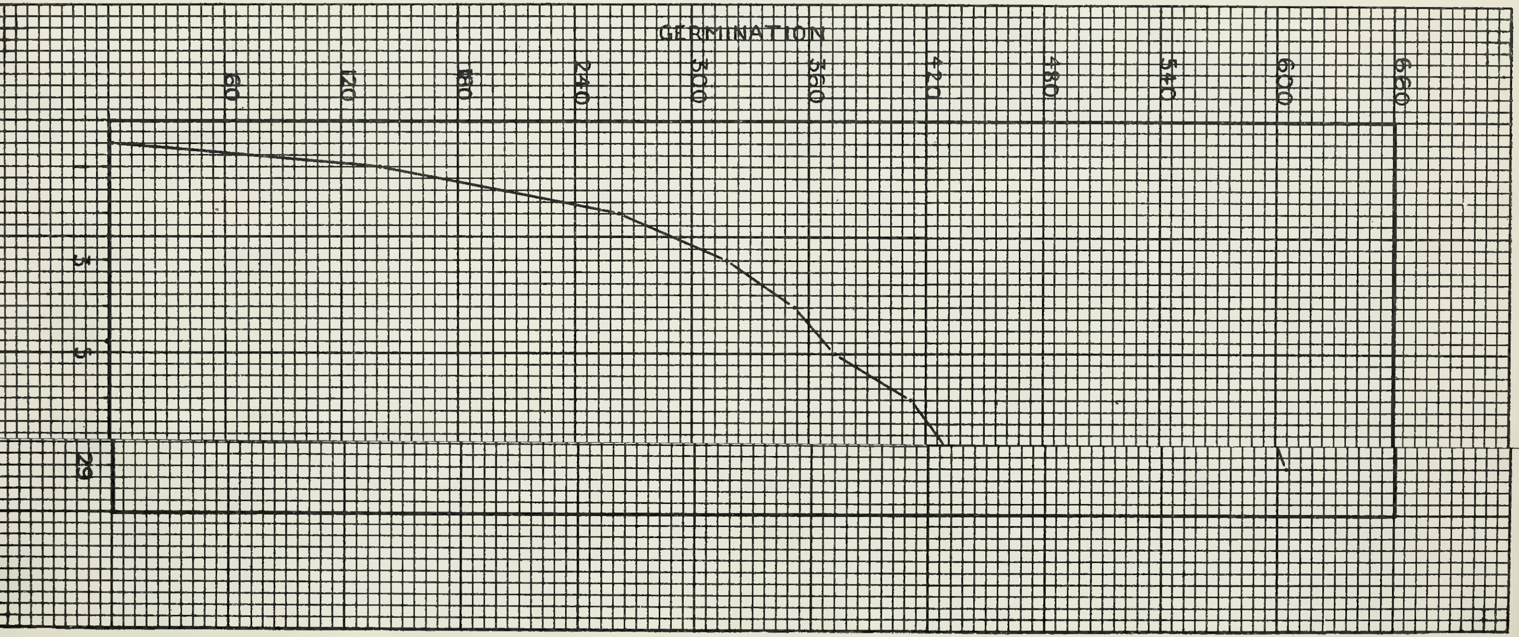


Fig. 5—Germination of Untreated Acacia Seed in Laboratory, 18 Samples of 100 Seeds each.

Fig. 5—Germination of Untreated Acacia Seed in Laboratory, 18 Samples of 100 Seeds each.



difficulty. One may infer that most of those eaten will pass through unharmed and will start under ideal conditions.

Seeds of an exotic Acacia were collected by Mr. J. Mullins at the mouth of the Kariega River in January 1948, among the droppings below a dove's nest. These seeds were also viable, and germinated between the 20th and the 87th day. This indicates that doves might also spread *Acacia karroo*, but it has not been possible to find out whether they actually do so.

GERMINATION

(*a*) *In the Laboratory*

The seeds were placed in petri dishes, on filter paper kept moist with rain water, and the tests carried out at room temperature. The mean temperatures during summer and winter were 63 and 59 degrees respectively, and the greatest diurnal range observed was 9 degrees. All seed which appeared to be damaged in any way was discarded, and to protect the sample against fungus a commercial preparation was used. This proved ineffective, but the fungus did not affect the results because the seed germinated in spite of it.

Seeds show the first signs of germination by swelling to about twice their normal size, thus causing the testa to break and peel off in flakes. As a rule the radicle appears first, but occasionally the cotyledons do, in which case there is usually weak growth which soon ceases completely. The seed coat is shed when the radicle is from half to two inches long, and at this stage there is a well-marked frill differentiated on the radicle about half an inch from the cotyledons. When the total length of the seedling is about three inches the lateral roots begin to appear. The leaf at the first node is once pinnate, thereafter the leaves are bipinnate, with the number of pinnules increasing from the base of the plant upwards.

The seeds are unpredictable as to germination time. In the laboratory tests some germinated within a few days while others from the same batch (and thus from the same parent) have lain dormant for more than three years before germinating. The sample with the least germination has in that time produced only nine seedlings from a hundred seeds. The highest figure is 68. Results for the first 29 months are given in Table 20 and Figure 5. All samples still contain apparently sound seed, and germination is continuing. It may be brought about without delay in any sample by making an incision in the seed coat of one of the dormant seeds. Table 20 shows that the germination is comparatively rapid during the first six weeks only, and that besides this proportion of seeds which sprouts quickly there is a reserve of resistant ones which, germinating very irregularly, spreads the risk of an erratic climate and gives some seedlings a chance of striking suitable weather conditions. Similar behaviour has also been noted in *Elytropappus rhinocerotis* by Levyns (1935), who points out the advantage gained, and by Dyer (1935), who, working on *Euphorbia obesa*, found that four out of ten seeds germinated within a week. There were no more until practically a year later, when four more appeared within a few days.

In Elytropappus, the reason for this erratic germination has been proved to lie in the embryo, but the extremely hard testa of *Acacia karroo* suggests that impermeability of the seed coat may be the cause. As a preliminary to the investigations, the seeds were soaked in boiling water, and this greatly hastened germination. Over 100 days, and in an average time of 14·5 days, 63 per cent germination was obtained. A control batch over the same period gave a germination of 21 per cent in an average time of 22·6 days. In this respect, *Acacia karroo* behaves in much the same way as *Acacia mollissima* and *Acacia decurrens*, as shown by the work of J. B. and E. Osborn (1931). In their paper they state that the action of the boiling water is twofold:—

"It appears to be quite evident that the treatment of the seed with

TABLE 20

GERMINATION OF ACACIA MONTH BY MONTH

Sample No.	Batch No.	MONTHS																													Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
3142	1	12	5	0	0	0	0	2	2	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	27
	2	10	1	3	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	21
2706	1	5	3	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	14
	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
2705	1	8	4	3	1	1	0	1	2	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	25
	2	10	4	2	3	2	2	0	2	1	1	0	2	0	0	1	2	1	1	0	0	0	0	1	1	1	1	0	0	0	38
2702	1	13	4	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21
	2	4	3	2	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	14
2623	1	3	15	13	9	2	4	3	0	0	2	0	1	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	2	59
	2	3	4	11	5	7	12	4	2	1	2	1	1	1	1	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	59
2601	1	6	7	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	21
	2	8	4	1	3	0	1	0	3	0	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1	0	0	25
2598	1	5	5	2	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2	2	1	1	1	0	24
	2	6	0	0	1	1	3	0	1	0	0	0	0	2	1	0	0	0	1	0	1	1	0	0	0	2	0	2	0	0	22
2597	1	1	14	2	1	0	1	0	1	1	1	0	4	0	3	2	0	1	2	0	3	3	2	2	3	3	3	1	0	0	54
	2	3	4	7	3	1	4	3	1	0	0	2	1	1	0	1	1	5	4	2	0	1	0	0	3	0	0	0	0	2	49
2592	1	17	27	2	1	1	1	1	0	1	0	0	0	2	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	56
	2	18	19	6	5	3	8	1	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	2	0	0	68
		140	123	55	35	21	39	18	15	7	7	7	14	9	7	6	6	10	11	5	5	8	3	4	10	13	5	8	4	10	

Note.—The tests were started in the middle of the first month.

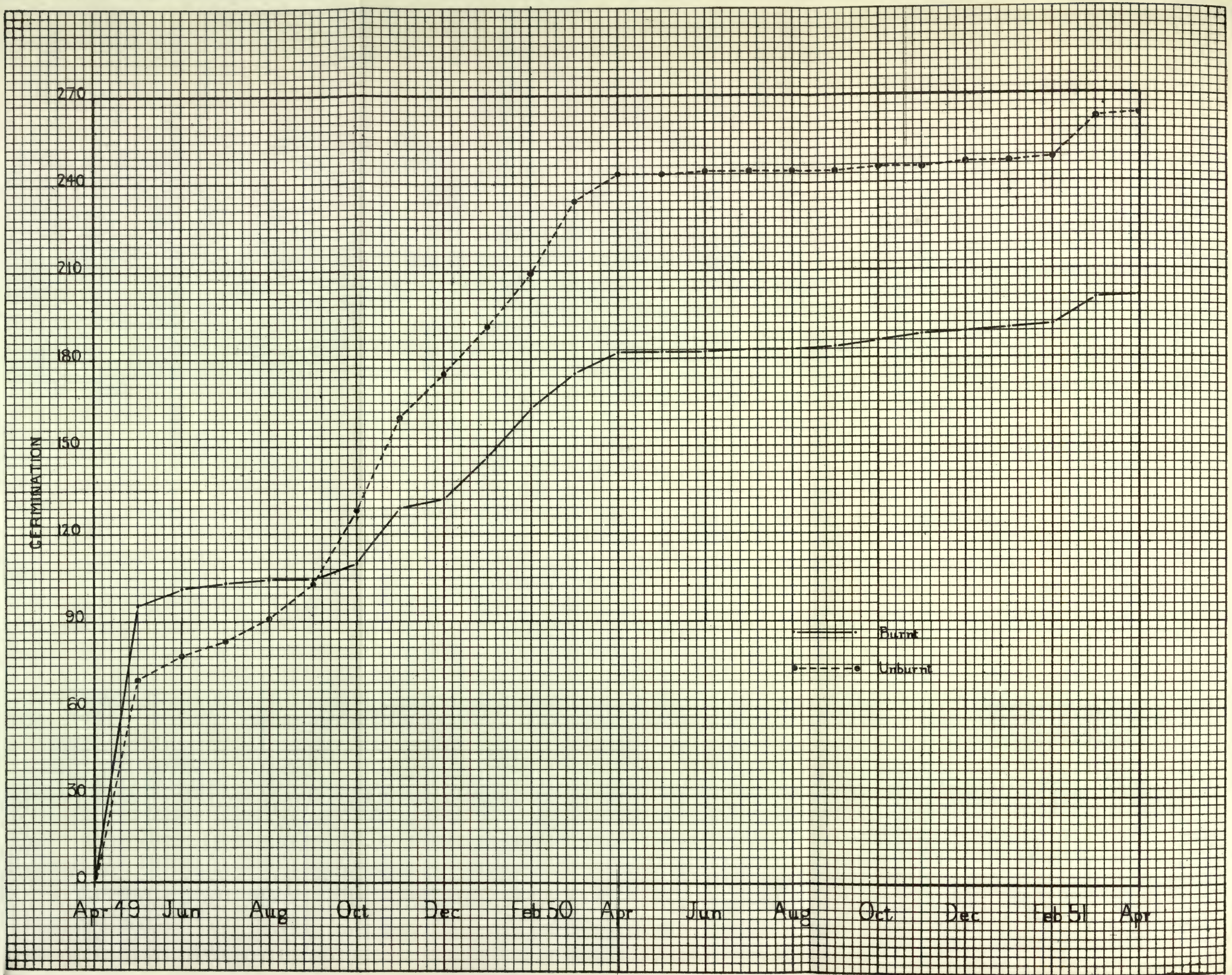
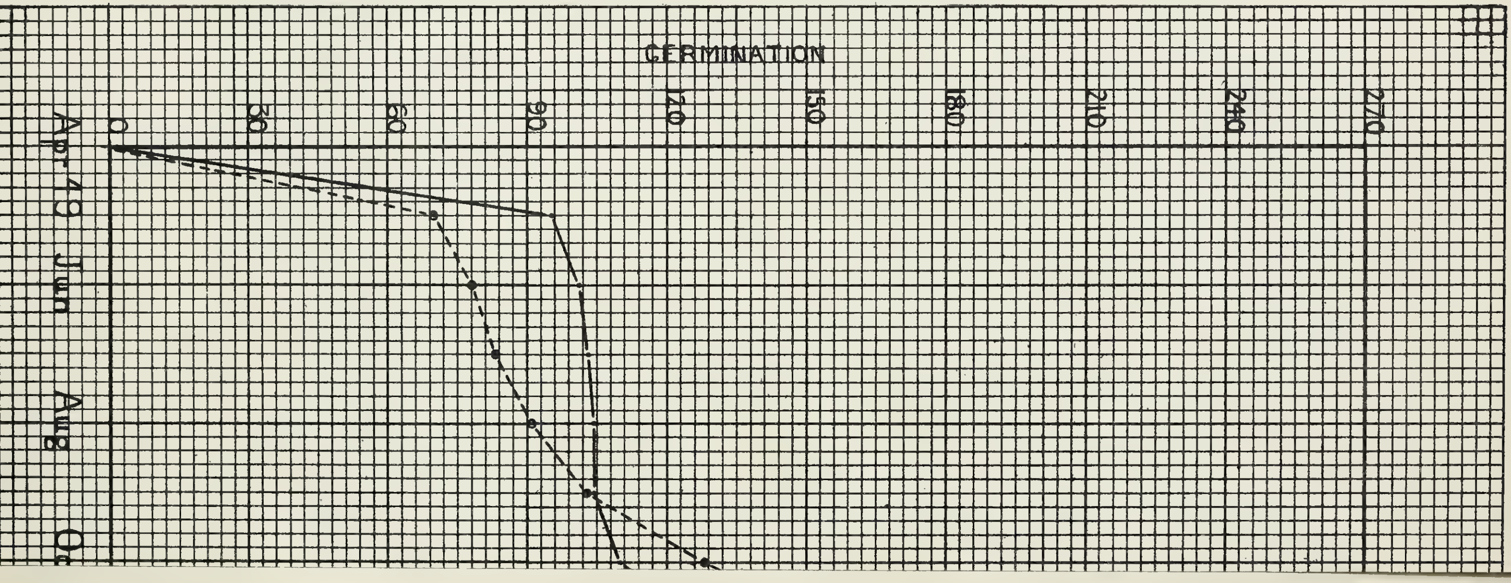


Fig. 6—Germination of Burnt and Unburnt Acacia Seed, 400 Seeds in each Sample. (Note low germination during winter.)

Fig. 6—Germination of Burnt and Unburnt Acacia Seed, 400 Seeds in each Sample. (Note low germination during winter.)



boiling water not only renders the seed coat permeable, but it must also set in action certain physical changes within the seed, which cause seed treated at an earlier date to germinate more rapidly."

This does not appear to be true of *Acacia karroo*, for it has been shown consistently in field and laboratory tests that although the treated samples *as a whole* were quicker to germinate, the first seedlings might be from either treated or untreated samples. In addition, a far quicker and more even germination was obtained by filing through the testa than by treating the seeds with boiling water, and the data in paragraph 2 on page 48 show that germination is not delayed in immature seeds with a green and soft seed-coat. After-ripening is necessary only in the freshest seeds, the process being completed so quickly as to be of little practical significance. The indications therefore are that irregularity of germination is bound up solely with the impermeability of the seed coat.

It has been reported by Phillips (1931, p. 303) that seeds of *Acacia melanoxylon* germinate more readily after scorching. Sim (1907, p. 212) states that this is true also of *Acacia karroo*, the seeds of which germinate better after being "half roasted", and Mr. E. D. Matthews of Tukulu, Alice, reported large numbers of seedlings after a grass fire had passed through a portion of his farm. This effect of fire might be expected from the results of the scalding experiments. To show it experimentally and to find how much the seeds were affected, the following test was carried out:—A four-gallon paraffin tin was cut in half lengthwise, and the halves filled with sand. A sample of 800 sound seeds of *Acacia karroo* was halved, and 400 seeds placed in each tin and covered lightly with sand. Dry grass was heaped six inches deep over one tin and set alight. Both tins were thereafter put in the greenhouse and the sand kept moist. Germination was shown in both tins on the third day by the uneven raised parts on the surface of the sand. The first seedling broke through soon afterwards, and thereafter they appeared rapidly. In the burnt tin many of the testas were charred, and the cotyledons themselves were sometimes scorched and shrivelled through the action of the heat, but there was no bad effect observed on the plants in consequence. Results are given in Figure 6. Germination of the burnt seeds is considerably more rapid at first, but after five months it is overhauled and passed by that of the untreated seeds. Now, 19 months after the experiment was started, the figures are 188 and 245 respectively. Germination is still taking place. The indications from this experiment are that burning will cause a flush of seedlings, but that the final number is likely to be less than would be the case if the seeds remained unburnt, probably because the fire kills part of those it passes over.

The viability is high, as is shown by a test done with four seed samples, varying in age from one month to two years. A hundred seeds from each sample were nicked and germinated at room temperature. None germinated after the eleventh day. Results were as follows:—

1st day	0
2nd day	0
3rd day	271
4th day	62
5th day	5
6th day	1
7th day	9
8th day	0
9th day	0
10th day	0
11th day	6
	354

Average germination 88·5 per cent.
Average time 3·4 days

The seeds showed surprising longevity. All those experimented upon were germinated at room temperature and were nicked so that results could be obtained without an unreasonable delay. Results were as follows:—

1. No germination was obtained from seed collected before it had grown to its full size.
2. Pods picked before they had dehisced gave a sample of seed fully formed but swollen and still quite green, and soft enough to be squashed between finger and thumb. Its germination test began the day it was collected. 78 per cent germinated in an average time of 8·8 days. A control batch untreated was germinated at the same time and under similar conditions, and behaved in very much the same way. 82 per cent germinated in an average time of 10·8 days. Germination ceased on the twenty-second and on the twenty-fifth day respectively. The significance of these results is discussed on page 47.
3. Seed was obtained from pods at a slightly later stage but still before they had dehisced. This was soft enough to be cut by the thumb nail but turned the edge of a razor blade. The germination was 89 per cent, in an average time of 5·5 days.
4. When the pods had already dehisced, fresh seed collected from them sprouted normally—95 per cent, average time 4·1 days.
5. Seed 2 years old—97 per cent, average time 3·2 days.
6. Seed 10 years old (E 864 from Estcourt Pasture Research Station, collected on 9th September 1939)—59 per cent, average time 7·8 days.
7. Eight seeds were obtained from a herbarium specimen collected 28 years before at Carlisle Bridge (T. B. Bowker No. 59, May 1921). In spite of the fact that the herbarium specimens are poisoned with mercuric chloride about once every six months, four seeds were viable and germinated in an average time of 3·3 days.
8. Of 5 seeds over 57 years old, also from a herbarium specimen (W. G. Bennie No. 27, Lovedale, 27th January 1891), two were viable. They germinated on the twelfth day, but were lacking in vigour and made slow growth. As the seed-coats became covered in fungus, they were removed from the cotyledons and the plants placed in damp sand. Having continued to weaken in spite of careful treatment, they died, one four and one eight weeks after germination. Three more of these seeds were tested on moss wetted with wettable *Spergon* according to a method used in the Division of Botany and Plant Pathology to guard against fungus attack. All failed to germinate, the cotyledons breaking down to a paste within 3 weeks.

The remarkably long life of the seeds appears to be a generic characteristic. Guppy (1912) quoting Gola (1905) states that legumes in general have highly impermeable seeds and that Acacia seeds are among the most resistant. He also gives an interesting observation by Ewart (1908)—that 60 per cent of Acacia species have seeds which remain viable for more than 15 years. Ewart tested in all 2500 seed samples from various genera and species, and found that less than 1 per cent of them remained viable for this length of time.

It would appear that seeds buried in the ground would not remain viable as long as others stored in the dryness of a herbarium cabinet, because of the fluctuations of temperature and moisture, mechanical abrasion, the work of soil organisms and the like, but Phillips (1926) has shown that the seeds of *Virgilia capensis*, buried over 30 years, were 95 per cent viable. Whether this would be true of *Acacia karroo* cannot at present be established, but the probability cannot be ruled out.

(*b*) *In the Field*

Preliminary tests were carried out in the field in the spring of 1947. Seeds were planted at a spacing of three inches and roughly half an inch below the surface in holes made with small lengths of fencing wire, the seeds being afterwards lightly covered with soil. The tests were made from a supply of hand-picked mixed seed so that irregularities arising from damaged seed and strain differences might be eliminated, and plots were laid out on level ground at various points in grassland and cultivated ground. No watering was done. Although the possibility cannot be precluded that field germination figures may be affected by chance seeds, every possible precaution was taken against this. The plots were put to windward of seeding trees, and kept free of animal droppings so that the only risk of extra seeds was from those that might have been already buried in the soil. From time to time the plots were visited and the position of each seedling was recorded. In this way a check was kept on all new ones coming up. Some came up unnoticed, and were seen only when established—presumably therefore a few may have died without being seen and thus perfect accuracy cannot be claimed for the field counts. It was feared that newly germinated seedlings might die and disappear without being seen, but the withered remains were found to persist so long that this is unlikely to have been a source of error.

The total germinations over eighteen months were 134 out of 2040 in grassland and 544 out of 4760 under cultivation. These figures work out to 6·6 per cent and 11·4 per cent respectively. This field germination was also erratic, as follows naturally from the laboratory tests, and the last seedlings to germinate up to the present time did so 423 days after the inception of the experiment. Although the germination seems surprisingly low, it is probably the maximum that might be expected in any one season, because there were good rains evenly spread over the summer. From the beginning of October 1947 to the end of March 1948 the total was 16·26 inches.

In the grassland, similar plots were established at the same times as the planted plots and adjacent to them with the one difference that instead of being planted in holes, the seeds were laid on the surfaces of the plots either on the bare ground or in amongst the grasses, as the spacing determined. It was found that displacement by wind and rain was slow, so that most of the seed was in position by the time germination was taking place in the planted plots. The numbers of viable seeds was, however, cut down by the attacks of insects, of which the commonest was *Nariscus cinctiventris*. Germination results up to 8th March 1949 were as follows:—

Plot No.	*Germination*
32	7
33	0
42	0
46	1
50	1
30	10
37	1
41	3
45	1
49	0
	24 out of 1700 or 1·4 per cent.

This low germination for surface sowings tallies with the results given by Cohen (1940). He kept seeds of *Acacia karroo* on the soil surface at air temperature, but there was no germination in 62 days in spite of daily watering.

Germination of the surface sowings at Grahamstown was delayed in the same way as that of the planted plots. The last seedling so far observed germinated in plot 32, and was about three days old on 8th March 1949, 16 months after sowing. Although the total germination is so low, seeds germinated well on wet filter paper in a petri dish set in the sun, from which one may infer that it is the lack of water which inhibits surface germination, and that surface germination is likely to be small, and confined to those seeds which fall in hollows or well shaded places. Good seasons, however, might be expected to bring on a sudden abundance of seedlings.

This may be the explanation of Bayer's observation (1933) that the trees of an Acacia thicket are often of the same size. The same thing is strikingly shown on the Grahamstown commonage to the east of the town. This area has already been referred to, but a repetition of certain points is convenient here: over the area studied (30 acres) there are 29 trees over 6 feet in height, dotted over the flat and standing out conspicuously above a strangely uniform growth of seedlings growing in dense patches between them. These number nearly 4400 and most of them are are about 2 feet in height. On detailed examination one notices many fluctuations over and under the average, looking at them as a whole one cannot but be impressed by their even size. It is not possible, however, to establish within what limits their ages may be the same. Ring counts were tried but the different zones were too obscure to give any results.

There is therefore a certain amount of evidence that trees may not gradually increase in number but that combinations of factors now and again make conditions suitable for sudden increases. The behaviour of *Acacia karroo* in its germination and establishment suggests that the amount and distribution of the rainfall are the limiting factors but it must not be forgotten that there is always a reserve of impermeable seeds which will not germinate with the rest, however good conditions are.

Results from the laboratory experiments on scalding were confirmed by tests in cultivated ground. A sample of seeds was mixed and divided into halves of 2380 each. One lot having been scalded and air-dried, both were planted in the spring of 1947. The scalded seeds germinated a great deal more rapidly and after eight weeks (when the germination of both samples had slowed down to produce the usual sporadic seedlings) a count showed that the figures were 17·3 per cent for the treated and 5·6 per cent for the untreated seeds. The germination of the untreated seeds never caught up with that of the scalded ones, this indicating that the scalding does not damage the seeds as does the burning treatment described on page 47.

The results of all these tests show that any harmless treatment which will make the seed-coat more permeable will very much reduce the germination time. It cannot yet be said that the germination will be higher, for there is no certain means of establishing the final germination figures except where the seeds have had their coats cut through. Scalding is uncertain even if boiling water is used, for the water remains hot for varying times according to the amount so that one can never be sure that all the seeds have been sufficiently treated, or that some have not been damaged by the heat.

ESTABLISHMENT

The seedlings used in the field germination were kept under observation from October 1947 until 1950. Those under cultivation were regularly weeded and the mortality was negligible—only one seedling died out of over 500, as far as is known. In April 1949 they were in perfect health and averaged 17·8 inches in height, with a basal diameter of between a quarter and half an inch. As their continued growth threatened to turn them into a nuisance, they were chopped out in February 1950.

In the grasslands, only 8 remained out of 158 by October 1950, a rate of establishment of 5 per cent. These results indicate that competition from grasses is far too strong to allow the easy establishment of *Acacia karroo* in a dense sward. The plants were too small to warrant measuring. Some of the plots were in protected grassland, and the seedlings grew up in shade. Even here where they were etiolated, the tallest ones were about 4 inches high with thin and delicate stems (see photograph 8). Where there was no shade at all they were stubby and in height only about one and a half inches. It is possible that the loosening of the soil in the cultivated plots may have favoured the seedlings in them. This matter has not yet been investigated.

As the commonage grasses are cropped short all the year round, there is practically no competition for light even at ground level, and it seems that competition for water is a strong factor governing the relationship of grasses to *Acacia karroo*. Murray and Glover (1935) state that Themeda (which is dominant in these areas) uses a great deal of water near the soil surface. It "has a very much branched and shallow root system which extends a considerable distance in a horizontal direction forming a close network a few inches from the surface of the soil". The probability of the decisive part played by competition for water is supported by the lysimeter data of the Agricultural Research Institute, Pretoria, as reported by Theron (undated), who emphasises the amount of water needed by plants and mentions in particular the large requirements of grass, especially where growing actively. The proportion of carbon dioxide in the soil air probably plays a part as well in influencing the relation of grasslands and Acacia (see page 29).

EFFECT OF BROWSING

Sim (1907, p. 212) states that goats are "the surest means of keeping the tree down," but he gives no supporting evidence for this remark.

Dyer (ms.) does not consider goats a satisfactory means of controlling Acacia. Reporting the results of experiments carried out to test the effect of intensive browsing by goats, he writes as follows:—

> "Although none of the mimosa plants have been killed by the grazing their growth has been considerably reduced, and it appears very unlikely that they would ever increase in size while under the grazing of the goats. However, owing to the natural vigour of the mimosa it is doubtful whether this grazing would ever result in the total eradication of mimosa in a reasonably short time. The goat therefore can only be classed as a means of control and its usefulness in this direction will naturally vary according to the veld conditions. Owing to the admittedly destructive nature of goats, I consider that to attempt to control the growth of a large quantity of mimosa in grassveld would be uneconomical and I consider that the mimosa growth should first be removed by other means and later a very limited number of goats allowed on the veld."

Irvine (1941, p. 221) states that goats take grass by preference and that "bulk eradication by goats does not appear to be possible while any grass remains". Mixed stock play practically no part in eradicating Acacia. Of the 96 seedlings under observation on the Grahamstown commonage only three were cropped by animals in spite of the fact that the area is grazed heavily and without rest, and only one of these seedlings died.

It thus seems clear that Acacia is proof against all domestic animals with the doubtful exception of goats, and that it is not harmed by grazing. These observations are in accordance with its thicket formation in heavily grazed areas.

Laboratory tests show that pruning is detrimental only if the plants are cut off near the base. The tests were done on 85 seedlings, grown under cultivation until they were two months old, and on an average one and a half inches tall. With a pair of scissors 42 were cut off flush with the ground. Two recovered from this treatment. The rest were cut a quarter of an inch from the soil surface so that the lowest leaves remained on the stump, and of these all continued growing strongly. More exact tests were then made with younger seedlings.

It was found impossible to get a complete kill at any stage by snipping off parts above the cotyledons; although there was some mortality even the youngest were usually able to withstand amputation as far as the loss of one cotyledon together with the young shoot. Beyond this point they were never able to survive. It seems that no regeneration of the stem can take place below the cotyledons. Contrary to these observations is the following extract from the letter F 6256/R 9201 of 2nd July 1928 from the Chief Conservator of Forests to Mr. S. Rippon, P.O. Highlands Station, Albany, on the eradication of mimosa trees: ". . . there is usually, to a limited extent in grassland, regrowth from root suckers". This may be a mistake, for no supporting evidence has so far been found for regeneration from roots. Scott (1949, p. 40) confirms that Acacia coppices if cut above the junction of root and stem, but not if cut below this point. In trees more than a few years old, however, it is extremely difficult to establish where the junction is situated.

Two pamphlets by Dyer (1930, 1931) give information on the prevention of coppicing by the use of arsenic compounds.

EFFECT OF BURNING

It has been suggested by Wolhuter (1948, p. 121), Phillips (1934, p. 238), Galpin (1926) and Scott (1949, p. 99) that grass fires are important in checking the encroachment of trees, thorn scrub in particular.

The influence of fire was tested on established groups of *Acacia karroo* seedlings which had been grown for the purpose. The plots contained between 40 and 50 seedlings each, and the burning was done on calm days by heaping dried grass over the plants and lighting it. For slow burns, the grass was piled up for 3 inches, for fierce burns 6 inches. The following are the results:—

At 1½ *inches, age up to* 6 *weeks*

Slow burn: Although scorched, the seedlings remained green for a day or so before turning brown. All were killed.

Fierce burn: The seedlings were charred and blackened. All were killed.

At 4 *inches, age up to* 8 *weeks*

Slow burn: As for 1½ inches.

Fierce burn: As for 1½ inches.

At 14 *inches, age up to* 12 *months*

Slow burn: There was little immediate effect visible except the scorching of the lowest leaves. By the next day, however, all the leaves were dead except a few which were on straggly plants, and were thus hanging over the edges of the plot. These also had died within a month. None of the plants themselves were killed, and a month after burning they were making strong growth from the base.

Fierce burn: The effects were similar to those found in the slow burn, but intensified. Six of 40 plants appeared to have died within the first month, but later made a complete recovery, so that there was no mortality. New growth was made in the same way, a feature of this being the death of the original stem and the development of a number of coppice shoots in place of it. Of the burnt plants surviving, 100 individuals gave rise to 346 stems. In the control plots there was only a slight growth of basal shoots, the ratio of individuals to total stems being 100 to 130.

These observations show that there is no hard and fast rule governing the influence of fire on *Acacia karroo*, but that it depends on the size of the plants and on the fire. Scott (1949, p. 99) reports from experiments carried out in Natal that the results of burning are influenced also by the time of the year in which it is done, and states that spring burning is the most effective.

Far from being of value as a means of eradication of well-established scrub, fire is likely to bring about a thickening of it by encouraging the growth of coppice shoots. It could, however, be used as a means of control when the area had once been cleared of older plants. This is suggested by the experiments described and by the work of Cook (1939), who has demonstrated that a good growth of grass burns with the evolution of very high temperatures. The method could be used firstly to stimulate the germination of dormant seeds and subsequently to kill the resulting seedlings, and could be dispensed with when once the reservoirs of seed had been depleted.

TYPE NO. 2—FORT COX SCRUB

COMPOSITION

This type of scrub, shown in photograph 9, has a rainfall of about 23 inches. Tree growth is short, varying in height from about 7 feet on the stonier parts to about 10 feet on the hills and in the sheltered areas where there is deeper soil. Bushes are spaced in widely differing densities, now aggregated into clumps, now scattered, the spaces being covered in the more protected places with Themeda, Digitaria and Panicum mixed with various shrublets of which the characteristic species are *Lasiocorys capensis*, *Helichrysum rosum* and *Aster muricatus*. Quadrat figures are given in Table 35, page 108.

The absence of the more mesophytic trees gives the scrub a grayish appearance and spiny and thorny plants are common, as is usual in drier localities (Bews, 1927, pp. 67, 75; Phillips, 1931, p. 135). Some stunted specimens of *Buddleja salicifolia* and *Sideroxylon inerme* occur, but these plants are characteristic more of the forests, in which they attain their best development. A few trees appear to be at home equally in the forests and in the scrub. These are *Carissa bispinosa*, *Grewia occidentalis*, *Scutia myrtina* and *Cussonia spicata*. The dry character of the scrub is shown by the presence of individuals of *Euphorbia pentagona* and *Rhigozum obovatum*, and of a few communities of *Portulacaria afra* and *Senecio pyramidatus*. *Olea africana* predominates on the dolerite soils, growing up to twenty feet, as do the widely separated groups of *Euphorbia tetragona*. The general level of all the different tree species, however, is about 10 feet. Visibility where the ground is level is usually over 80 yards.

No epiphytes are present except a thick growth of lichens on nearly all the trees, and the ferns are represented only by a few specimens of the xerophytic *Pellaea hastata*. Lianes are likewise very poorly represented by a little *Secamone frutescens*. There is no Usnea. Phillips (1929, p. 103) has reported that it flourishes in dry and sunny situations, and that it grows poorly or is absent in weak light and under conditions of high humidity, so that "rapid development of the organism under dense forest conditions is entirely impossible". He does not mention that there is a limit to its existence where dry conditions are excessive, but this appears to be so. Although type 2 is too arid for it, it grows well in type 3.

Confined to the banks of the Keiskamma River is a mixture of *Celtis kraussiana*, *Acacia caffra*, *Podocarpus falcatus*, *Combretum salicifolium* and *Salix capensis*, conspicuously higher than the surrounding trees and indicating that this part is well out of the karroid area (see pages 32-4). A very little *Acacia caffra* grows on the hottest and driest parts of the neighbouring hills as well, but this behaviour is out of the ordinary (Sim, 1907, p. 210). There are numerous dry watercourses on the slopes. Their vegetation is not differentiated from that of the surroundings.

EFFECTS OF GRAZING

The trees in general are too small to yield anything useful in the way of timber except wattles for building, and firewood. Their chief economic use is in providing browsing for stock, but woolled sheep are at a disadvantage because of the rough character of the vegetation. Probably the veld would be best utilised by cattle, for the reason that their height enables them to reach most of the tree growth without difficulty. They could be followed by Persian sheep or goats to clean up the more impenetrable parts of the scrub to which the cattle cannot gain access. As will be shown later, this cleaning-up process is essential if the veld is to be maintained in a good state, and sheep and goats can play a valuable part provided that their grazing is strictly controlled. One feels that their bad reputation in respect of ruining veld is perhaps somewhat undeserved, and caused by the fact that their more efficient feeding habits enable them to keep condition so that they are allowed to remain on a particular piece of veld long after they ought to be removed. If the plants are watched as well as the animals the damage need not necessarily occur.

A feature of the tree growth is that it is not deciduous; accordingly the animals have a supply of green food through the winter. In addition the grasses remain reasonably nutritious even when frosted, and stock can be maintained during the dry season, and even fattened, without supplementary feeding.

It is the open grassy spaces which suffer most when overstocking takes place. Between the trees there may be all stages of denudation from areas of bare rock or stony rubble to parts less heavily grazed by reason of protecting thickets, banks or rocks. Mixed with bits of grass is a ragged growth of ruderals like *Gomphrena globosa*, *Alternanthera repens*, *Venidium arctotoides* and a little *Chrysocoma tenuifolia*. Cynodon is always present in varying amounts and is the most valuable single plant there is from the point of view of checking erosion. Another equally effective but scarcer is *Setaria neglecta*, which, forming mats several square yards in extent, not only holds the soil but has leaves upright in habit that filter out the sand and coarser soil particles washed across them by floodwater. New growth forms above the silt in the same way as a lawn covers over a top-dressing.

The successionally advanced grasses are seldom quite absent. Scraps of *Themeda triandra* and *Cymbopogon plurinodis* continue growing in clefts and crannies or beneath the densely set twigs of *Phyllanthus verrucosus* or *Randia rudis*, and their astonishing endurance is evident from the way in which isolated and exposed tufts remain alive though leafless even in the hottest and driest localities. They are found in a rainfall as low as about 12 inches in the Fish River Valley, in the form of relicts in the midst of patches of *Euphorbia bothae*. Complete extermination can however occur over fairly wide areas if protection is lacking, and parallel cases are reported by Cottam and Evans (1945) from Utah.

The trees suffer variously according to the animals concerned, for as is generally conceded, sheep and goats do more in the way of browsing than cattle. The intensity of the grazing also has a bearing on this subject. Woody growth is in general passed by where grazing is light and where consequently there is enough fodder provided by the grass, and where this happens trees can and do increase in number. This is shown by the fact that seedling trees become established in the land belonging to Fort Cox Agricultural School and make it necessary for scrub clearing to be carried out at intervals.

With heavy grazing the stock are forced to turn increasingly to the trees for food, and if this goes on indefinitely the species most sought after steadily disappear, as has been reported by Whitlock (1949, p. 59) of *Portulacaria afra*. This damage is, however, insidious, and a careful examination is necessary before it can be recognised, because the woody growth *as a whole* continues to spread under these conditions. Evidence is provided by the establishment of tree seedlings in overgrazed parts, and by photographs 10 and 11 which show this taking place in the closely allied type 3.

TABLE 21

BELT TRANSECT FIGURES

FORT COX SCRUB (TYPE 2)

Area: 4× 608 sq. yds.

Stems Listed: 1 inch diameter breast height and over

Species	Total Stems	Av. Ht.	Av. Diam.	Max. Ht.	Max. Diam.	Per cent Freq.
		Ft.	Ins.	Ft.	Ins.	
Acacia karroo	54	7	1·3	9	2	18·31
Azima tetracantha	30	7·6	1·5	9	2	10·17
Carissa bispinosa	4	6	1	6	1	1·36
Dovyalis zeyheri	1	9	2	9	2	0·34
Ehretia rigida	18	6	1·3	9	2	6·10
Euclea undulata	3	14	5·3	14	8	1·02
Fagara capensis	1	5	1	5	1	0·34
Gymnosporia buxifolia	15	8·4	1·5	10	3	5·09
Gymnosporia capitata	8	6·5	1·4	8	2	2·71
Gymnosporia polyacantha	6	9	1	8	1	2·03
Hippobromus pauciflorus	1	10	4	10	4	0·34
Jasminum multipartitum	39	14	1	14	2	13·22
Lycium sp.	1	5	1	5	1	0·34
Olea africana	37	8	1·8	14	7	12·54
Pappea capensis	1	1	6	10	6	0·34
Ptaeroxylon obliquum	1	13	5	13	5	0·34
Randia rudis	55	6	1	8	2	18·64
Rhus incisa	4	10	1·5	10	3	1·36
Rhus sp.	5	7	2	9	2	1·70
Royena sp.	1	6	2	6	2	0·34
Scutia myrtina	10	9·5	1·8	14	4	3·39
Totals	295					100·02

TABLE 22

ADDITIONAL SPECIES

FORT COX SCRUB (TYPE 2)

Woody plants (*a*) too small to be listed in the transect
or (*b*) noted outside the transect
or (*c*) noted in the same scrub type elsewhere in the district

Acacia caffra
Aloe ferox
Boscia albitrunca
Brachylaena sp.
Buddleja salicifolia
Capparis citrifolia
Cassine crocea
Cussonia spicata
Euphorbia tetragona
Grewia occidentalis
Phyllanthus verrucosus
Plumbago capensis
Putterlickia sp.
Schotia speciosa
Sideroxylon inerme
Tecomaria capensis
Zizyphus mucronata

It is only in times of great scarcity or with exceptionally heavy stocking that the damage to the bushes becomes noticeable. Mr. E. D. Matthews of Tukulu, Alice, has informed me that *Randia rudis* is not eaten on his farm where there is adequate grazing for his stock, but when the animals are desperately short of food they will eat bushes which are normally avoided, as is shown by the photograph of Randia in an overstocked area (photograph 12). As food becomes scarcer they are driven to the extremity of eating the thorny cladodes of Opuntia (photograph 15), and their hunger and the state of their mouths may be imagined. It is reasonable to suppose that these conditions would eventually cause the destruction of trees, and that this can in fact take place is shown by photograph 16 taken in the dry scrub near Wolvefontein.

In the absence of any precise data regarding the rates of stocking only a general statement is possible—that overgrazing in the dry types tends to produce a thickening and a spreading of the scrub, except where the overgrazing becomes devastating in its effects.

EFFECTS OF DROUGHT

It has been noted that the woody growth of type 2 is severely affected by a drought in comparison with the types above it. Towards the end of the 1949 drought the shrivelled and bleached foliage between Fort Cox and Burnshill gave the veld an appearance of having been blighted by frost. *Olea africana* and *Ptaeroxylon obliquum* were very sensitive, being among the first to wither. Even *Randia rudis* lost its leaves although it favours dry localities. Others were *Scutia myrtina*, *Cassine croceum*, *Gymnosporia buxifolia*, *Putterlickia pyracantha* and *Allophylus decipiens*. There were, however, many of these trees which by virtue of some localised compensatory feature kept their foliage among stricken ones of the same species. *Cussonia spicata* was not affected at all, so that the large leaves remained green even under the most severe conditions. This is probably bound up in some way with the moisture content of the roots, of which Sim (1907, p. 230) states:—

> "During times of scarcity the Natives dig out the large succulent roots of this tree and live more or less upon them. They have a slightly acidulous taste, and when freshly dug are cool and sappy, and about as easily chewed as a turnip."

TYPE NO. 3—NQHUMEYA SCRUB

COMPOSITION

Type 3 is found on the north-facing hill-slopes from Keiskammahoek more or less to Burnshill, and its general appearance may be seen from photographs 17 and 18. The rainfall is higher than in type 2, neighbouring gauges indicating that it is probably about 26 inches. There is a taller and denser growth of trees, including several which have not been recorded from type 2, and of these the most important are *Canthium ventosum*, *Chaetacme aristata*, *Royena lucida* and *Vepris lanceolata*. It is too dry for *Entada natalensis*, *Burchellia bubalina*, *Podocarpus* spp., *Rapanea melanophloeos* and *Rhus legati*. The remarks on the vegetation of the streams and watercourses in type 2 apply here as well. Scattered communities of *Euphorbia tetragona* are present. An occasional plant of the epiphytic *Angraecum mystacidii* may be found on the older trees, and ferns, although more numerous, are still the xerophytic ones which grow among the rocks rather than on the ground. Those recorded are *Pellaea viridis*, *Pellaea hastata* and *Cheilanthes hirta*. Lianes are also commoner, and include *Rhoicissus cuneifolia*, *Rhoicissus digitata* and *Cissus cirrhosa*. Although the slightly moister conditions are suitable for the growth of Usnea, which does not grow in type 2, it is the foliose lichens which form the characteristic covering to the stems and branches.

As in type 2, the trees furnish no heavy timber, being useful only for wattles, firewood and fodder. This may be inferred from the belt transects given in Table 31, page 74, which show that the average height is a little over 12 feet and the average diameter a little over 2 inches. The general visibility is in the neighbourhood of 50 yards.

A rather tangled undergrowth about 18 inches in height is made up of a variety of herbaceous plants which together with a sparse growth of grasses combine to form a dense cover, a hindrance to progress and a shelter to numerous rodent runways lying beneath it. The more characteristic plants are members of the *Acanthaceae*, *Asparagus* spp., *Croton rivularis*, *Sida triloba*, *Cluytia pulchella*, *Barleria obtusa*, *Abutilon sonneratianum*, *Plumbago capensis* and *Achyranthes* sp. In the hotter parts the Crassulas become more numerous and there are frequent patches of *Cotyledon orbiculata*.

Thinly wooded areas are common and there is no definite canopy. Glades, prominent on the plateaus and ridges, and with the grasses in them predominating over the shrubs, usually contain scattered Acacia trees. These patches of grass are made up mostly of *Themeda triandra* (which is dominant) and *Digitaria eriantha*. Both of them are common in type 2 as well, but as with the trees, some grasses which have not been recorded in type 2 now make an appearance. They are *Hyparrhenia buchananii*, *Heteropogon contortus*, *Eragrostis capensis* and *Setaria sphacelata*.

The birds are substantially the same as those frequenting type 2 and comprise seed-eaters, *Lamprocolius nitens phoenicopterus*, *Lanius collaris*, *Clamator serratus* and *Upupa africana*. Although tortoises occur in type 2, they have so far not been seen in the denser vegetation of type 3.

SHALLOW SOILS

On many of these slopes the soil is only 18 inches deep and one finds it surprising that trees are able to exist, particularly when, as it often does, the soil overlies solid rock instead of loose stones or boulders. This structure occurs on the dolerite along Nqhumeya Ridge and is one easily and severely damaged by denudation of the veld (photographs 17, 18). The sheets of stone which eventually become exposed present for colonisation one of the most extreme habitats imaginable, unbearably hot to the touch on a summer day and cold on winter nights, with moisture fleeting and inadequate. The natural reclamation of such places by a new covering of plants and soil is an exceptionally slow process which can be assisted artificially only in a limited way.

The lichens, as one would naturally expect, are the only plants able to exist on a flat rock surface, and by increasingly luxuriant growth they are able to build up slowly conditions better suited to the higher plants (Weaver and Clements, 1929, pp. 61–63). This gradual process is in practice shortened by hollows, cracks and loose stones on the rock surface, which provide soil, moisture and shelter where other plants are able to obtain a foothold. Flakes of rock break down fairly easily into a crumbly gravel, which is also of great assistance to the colonising plants.

Crassula muscosa is one of the first arrivals in the rock crannies, and catches silt and spreads outwards by rooting from its decumbent branches. It is often found associated with *Lampranthus stayneri* which forms dense mats up to 12 inches across. There is however no hard and fast rule governing the sequence or form of the early stages—they include ferns, mosses, liverworts and phanerogams, and differ in their relative proportions from place to place. The commonest are *Cheilanthes hirta*, *Anacampseros* sp., *Hyophila zeyheri*, *Bryum argenteum* and *Riccia* sp. Rather unexpectedly, the grasses are sometimes preceded by the sedges *Mariscus capensis* and *Cyperus teneriffae*, which are capable of living as soon as a little thin soil has formed, then soon afterwards *Microchloa caffra*, *Aristida bipartita* and *Cynodon dactylon* begin to appear, roughly in that order. They are mingled at first with an assortment of non-grasses so varied that a complete list would be little else than confusing, but one of these early arrivals is frequent and important enough to be conspicuous above the rest. This is *Falkia repens*, a prostrate matted herb which spreads over bare soil and binds it with a network of branching runners. It is widespread in all the drier localities where its very short growth protects it from the grazing which often destroys plants more upright in habit. Interesting points in connection with its reproductive cycle are that the pedicel curves downwards when flowering is over, bringing the ripe fruit in contact with the ground, and that the persistent calyx, having leaf-like sepals, shelters the seeds from the direct sunshine, and swells with rain to hold them in a soggy pocket. These facts doubtless enable germination to take place where the seeds would otherwise perish and they contribute towards making this plant an outstanding help in reclaiming eroded areas.

Earthworms are active even in the earliest stages of soil formation, their winding burrows when the earth is moist clearly showing that they venture out from the surrounding deeper ground and begin their work of breaking down the vegetable litter even when the soil is barely thick enough to cover them.

As the surrounding soil which borders on these sheets of rock often abuts upon them in the form of a perpendicular face, stock can cause rapid damage around the margins by breaking off portions of it piecemeal. The profile also lays itself open to severe erosion by flood water which runs down the earth walls in the form of small cascades and cuts the soil away. It is self-evident that revegetation and the formation of soil may be assisted by keeping stock away and by diverting the floodwater across areas better covered. Further aid may be given by packing lines of stones across the surface of the rock to provide shelter for the early successional stages and to slow down the speed of the water, after the plan adopted by Pentz in the reclamation of dongas in the Drakensberg Conservation Area. The slowness of soil formation on rock, however, makes it clear that such reclamation works must be looked upon as permanencies. There can be no hope that a single lifetime would be enough to allow these rock slopes to revert to pasture.

That the bed rock has been recently exposed is clearly shown by the small islands of earth remaining here and there upon it, by the clear and sharp transition between it and the soil at its edges, and by the fact that it is well below the level of this surrounding soil. A few of the rock faces show none of these features and thus indicate that they have been exposed possibly for many centuries. They usually take the form of the isolated hillocks shown in photograph 19.

If the eroded areas are where there is deeper ground, or where the soil overlies a rubble of stones and loose rock as shown in photograph 20, recovery is by comparison a quick matter. Even on badly denuded areas the early stage of cryptogams is usually wanting so that the succession starts at a higher level. In the open, *Falkia repens*, the pioneer grasses and mixed non-grasses are the earliest arrivals, mainly because their seeds are easily transported, as in the *Aristida* spp., or because scattered parent plants are present, as with *Cynodon dactylon* and *Falkia repens*, which are widespread and common and seldom completely exterminated by heavy grazing. If the establishment of *Themeda triandra* is delayed it is not because of an unsuitable environment but simply because continued trampling and grazing have destroyed it so completely that parent plants and seed are no longer available when the area is finally rested. Once a few relict plants have made new growth and set seed, its spread is rapid.

In wooded areas the grasses figure in the succession only to a small degree and a mixed undergrowth is built up. The stages have not been examined in detail.

EFFECTS OF GRAZING

One is forced to use loose terms when referring to the rate of stocking because it is uncontrolled and fluctuates enormously. The best that can be done is to state that unless very heavy indeed, the effect of grazing is to give rise to an increase in the area and density of the woody growth in the same way as has been described for type 2. In this respect the behaviour of the two types is closely similar.

TABLE 23.

BELT TRANSECT FIGURES

NQHUMEYA SCRUB (TYPE 3)

Area: 4×608 sq. yds.

Stems Listed: 1 inch diameter breast height and over.

Species	Total Stems	Av. Ht.	Av. Diam.	Max. Ht.	Max. Diam.	Per cent Freq.
		Ft.	Ins.	Ft.	Ins.	
Acacia karroo	2	10	1	10	2	0·29
Allophylus decipiens	43	11·8	1·5	24	3	6·30
Apodytes dimidiata	20	12·2	2·2	20	6	2·93
Brachylaena sp.	5	15·2	3·6	18	4	0·73
Buddleja salicifolia	1	23	3	23	3	0·14
Canthium ciliatum	3	8	1	8	1	0·44
Canthium mundtianum	2	12·5	1·5	15	5	0·29
Canthium obovatum	21	15·9	2·7	24	5	3·07
Canthium ventosum	2	9	1	12	1	0·29
Capparis citrifolia	13	12·1	1·9	20	3	1·90
Cassine sp.	55	14·8	2·9	24	12	8·05
Commiphora caryaefolia	2	10·5	2	15	2	0·29
Cussonia spicata	15	21·1	8·7	25	24	2·20
Dovyalis zeyheri	35	9·9	1·5	18	4	5·12
Ehretia rigida	17	10·7	1·4	16	2	2·49
Fagara capensis	22	12·4	2	19	5	3·22
Grewia occidentalis	58	12·6	1·3	18	2	8·49
Gymnosporia buxifolia	45	10·4	1·7	18	3	6·59
Gymnosporia undata	1	9	1	9	1	0·14
Hippobromus pauciflorus	40	14·7	1·8	25	4	5·86
Jasminum angulare	5	12·8	1	14	1	0·73
Jasminum multipartitum	1	8	1	8	1	0·14
Maerua racemulosa	1	9	1	9	1	0·14
Olea africana	50	13·2	3·8	24	12	7·32
Pappea capensis	1	9	1	9	1	0·14
Pleurostylia capensis	2	18·5	6	24	10	0·29
Ptaeroxylon obliquum	27	14·2	2·7	24	12	3·95
Putterlickia sp.	16	8·3	1	12	1	2·34
Randia rudis	11	7·6	1·2	9	2	1·61
Rhoicissus cuneifolia	6	18·7	1·2	25	2	0·88
Rhus longispina	1	14	2	14	2	0·14
Rhus refracta	6	13·7	2	18	3	0·88
Royena lucida	7	9·7	1·4	18	3	1·02
Royena sp.	32	13·8	2	18	2	4·68
Scolopia zeyheri	27	10·4	2	14	3	3·95
Scutia myrtina	27	10·4	1·2	18	6	3·95
Senecio brachypodus	4	13	1·3	15	1	0·59
Sideroxylon inerme	3	10·7	5·7	12	6	0·44
Tecomaria capensis	8	11·2	1	14	1	1·17
Trimeria trinervis	30	10·1	1·9	18	4	4·39
Vepris lanceolata	10	11·7	1·8	18	6	1·46
Zizyphus mucronata	6	10·3	1	12	1	0·88
Totals	683					99·92

TABLE 24

ADDITIONAL SPECIES

NQHUMEYA SCRUB (TYPE 3)

Woody plants (*a*) too small to be listed in the transect
or (*b*) noted outside the transect
or (*c*) noted in the same scrub type elsewhere in the district.

Azima tetracantha
Buddleja dysophylla
Calpurnia sylvatica
Capparis rudatisii
Carissa bispinosa
Chaetacme aristata
Cissus cirrhosa
Clausena inaequalis
Heeria mucronata
Ochna atropurpurea
Pavetta capensis
Plumbago capensis
Polygala myrtifolia
Royena villosa
Schotia latifolia
Secamone alpini
Secamone frutescens

TYPE NO. 4—ZANYOKWE BUSH

The tall type of bush growing mainly on the south-facing slopes between Keiskammahoek and Burnshill, and shown in photograph 19, has been classified as type 4. It probably owes its increased density and height over type 3 to the moister and cooler air from the sea and to the fact that it faces away from the sun. The matter has been discussed by Aitken (1922), Phillips (1931, p. 130) and Potzger (1939). Below the trees the light is noticeably dim, for a definite canopy is seen here for the first time, between 20 and 25 feet above ground level. This is not to be confused with the average height, which because of the large number of smaller trees beneath the canopy is just under 16 feet.

The general appearance is rendered a darker green by the increased numbers of broader-leafed trees, among which are several foreign to the two drier types. The list is given in Tables 25 and 26. Tree Euphorbias occur in the form of small and rare communities towards the margin of the bush only, and an easily recognisable plant appears—*Encephalartos altensteinii*. The exotic Opuntias which occur throughout the two drier types are not able to exist in type 4. The few exceptions form elongated and almost terete cladodes and do not branch, and afterwards fall over under their own weight.

The kloofs are dry except immediately after rain, and their vegetation is not differentiated from the surrounding vegetation.

Most of the trees support a dense growth of Usnea and other lichens, and besides the xerophytic *Angraecum mystacidii* and *Polystachya ottoniana*, a xerophytic fern is found here and there as an epiphyte. This is *Polypodium polypodioides*, which under conditions of drought shrivels into wisps of dead-looking tissue and unfolds to become green and fresh again when the rains come. Together with these two are cushions of moss on the tree trunks and on the stones, and a sprinkling of more mesophytic ferns, which include epiphytes and ground ferns, is able to exist. Common ones are *Mohria caffrorum*, *Asplenium bipinnatum*, and *Polystichum adiantiforme*. *Streptocarpus rexii* is usually absent. The presence of *Polypodium polypodioides* in type 4 indicates that the evaporating power of the air is less here than in types 1 to 3, where this fern is absent (Pessin, 1925, p. 28).

The number of lianes is increased by the occurrence (although as a rarity) of *Entada natalensis* and by two more species of Rhoicissus—*Rhoicissus digitata* and *Rhoicissus rhomboidea*—, and there are three plants which turn here into definite climbers after appearing as bushes or at most weak scramblers in types 2 and 3. These are *Scutia myrtina*, *Azima tetracantha* and *Royena* sp. *Ptaeroxylon obliquum* was once an important constituent if one may judge from the number of stumps which are to be found. At present there is a little small timber from the larger trees of *Schotia latifolia*, *Cassine crocea*, *Calodendrum capense*, *Harpephyllum caffrum*, *Podocarpus falcatus*, *Rhus legati*, *Scolopia* spp. and *Vepris lanceolata*, but in general the use of this type remains restricted to wattles, firewood and fodder. Undergrowth, shrubs and young trees provide some browsing, but most of the foliage by far is out of reach of stock.

Visibility between the trees is about 25 yards. Because of the density of the trees there is a plentiful supply of litter, and the resulting mould forms a soft and porous cushion over the surface of the ground. Hence in spite of overgrazing and heavy trampling, erosion to a certain extent is checked by a covering which originates out of reach of the stock. The undergrowth consists mainly of *Asparagus* spp. and members of the *Acanthaceae*. There is one representative of the various species of Plectranthus which are found in the higher woodland types—*Plectranthus* sp. near *Plectranthus thunbergii*—a prostrate form with leaves almost fleshy. One or two species of ground ferns occur as rarities.

Acacia is absent in the bush itself but fairly prominent round the margins where tree growth is more open and made up of the light-demanding species like *Gymnosporia buxifolia*, *Ehretia rigida*, *Rhus pyroides*, *Olea africana* and *Putterlickia pyracantha*. Younger trees of other species indicate that this marginal scrub is giving way before an invasion of the taller growth. There is even at the upper margins practically none of the macchia so characteristic of the higher forest types, but instead there may be a rough mixture of tall and short bushes together with the herbaceous *Gamolepis chrysanthemoides* and the grasses *Hyparrhenia buchananii* and *Cymbopogon marginatus*.

Apart from stragglers, mainly *Panicum maximum*, the only grasses found in the bush itself are *Stipa dregeana* and the forest grass *Oplismenus hirtellus*, but near the edges where the vegetation is more open one frequently comes across mats of the fine-leafed and short *Danthonia curva* growing where the bushes cast a light shade. Those round the margin are the same as those associated with types 1, 2 and 3, that is, a mixture of Panicum, Themeda and Digitaria. However, at the upper margin members of an entirely different grassland type may be found—the type known as sourveld, and a sign of the moister conditions of the higher altitudes. The grasslands are discussed in a later chapter. It must be emphasised that the sourveld species are usually uncommon, so that a search may be necessary before they are found, usually between boulders or in parts fenced off from the grazing lands. The ones most likely to be seen are *Harpechloa falx* and *Tristachya hispida*. They mark the end-point of what is often known as scrub or bush, and the beginning of forest.

There is a gradual thinning of types 1 to 4 in their transition to open grassland which presented difficulty in the preparation of the vegetation map and made their delineation a tedious and troublesome work. In the forest zone the tree growth was easy to plot, for it was clearly differentiated from the grassland, or from the macchia when macchia was present, so much so that the clearness or otherwise of the boundary was found to be a useful guide in deciding the affinities of the woodland (see also page 140.)

TABLE 25

BELT TRANSECT FIGURES

ZANYOKWE BUSH (TYPE 4)

Area: 4 × 608 sq. yds.

Stems Listed: 1 inch diameter breast height and over.

Species	Total Stems	Av. Ht.	Av. Diam.	Max. Ht.	Max. Diam.	Per cent Freq.
		Ft.	Ins.	Ft.	Ins.	
Allophylus decipiens	18	15·6	1·6	20	3	2·04
Asparagus sp.	1	12	1	12	1	0·11
Azima tetracantha	118	14·3	1·2	30	2	13·37
Calpurnia sylvatica	4	11·3	1·5	12	2	0·45
Capparis citrifolia	70	16·6	1·5	25	4	7·94
Capparis rudatisii	1	15	1	15	1	0·11
Cassine crocea	31	21·6	6·1	30	18	3·53
Cassine sp.	49	19·5	3·9	30	13	5·56
Chaetacme aristata	67	11·8	1·6	20	4	7·60
Cussonia spicata	6	19·2	3·3	24	5	0·68
Dovyalis zeyheri	3	20	4	24	7	0·34
Ehretia rigida	43	11·2	1·5	20	3	4·88
Entada natalensis	2	10	1	10	1	0·23
Euclea sp.	3	14·7	2	18	3	0·34
Euclea undulata	26	21·7	5·4	30	10	2·95
Grewia occidentalis	9	12·4	1·3	18	2	1·02
Gymnosporia buxifolia	19	10·5	2·2	18	6	2·15
Gymnosporia nemorosa	8	10	1·4	10	3	0·91
Gymnosporia undata	50	19·5	5·2	25	12	5·67
Hippobromus pauciflorus	63	15·4	1·6	25	4	7·14
Jasminum multipartitum	6	20·5	1	25	1	0·68
Maerua racemulosa	8	11·6	1·1	18	2	0·91
Olea africana	1	25	5	25	5	0·11
Pappea capensis	13	20·5	4·8	30	12	1·47
Pleurostylia capensis	2	11	2	13	2	0·23
Ptaeroxylon obliquum	19	18·2	3·1	25	10	2·15
Putterlickia sp.	10	9·4	1	12	1	1·13
Rhoicissus cuneifolia	12	21·7	1·2	25	2	1·36
Rhus pyroides	85	9·8	1·7	18	9	9·64
Rhus refracta	2	14·5	1·5	20	2	0·23
Royena lucida	3	16	1·7	18	3	0·34
Royena sp.	10	17·2	1·1	20	2	1·13
Schotia latifolia	55	18·7	4·6	30	18	6·35
Scolopia zeyheri	2	19	3	24	4	0·23
Scutia myrtina	34	10·7	1·4	24	4	3·85
Sideroxylon inerme	9	18·7	4·2	24	6	1·02
Teclea natalensis	19	13·4	2·1	18	5	2·15
Vepris lanceolata	1	25	14	25	14	0·11
Totals	882					100·01

Table 26

ADDITIONAL SPECIES

ZANYOKWE BUSH (TYPE 4)

Woody plants (*a*) too small to be listed in the transect
or (*b*) noted outside the transect
or (*c*) noted in the same bush type elsewhere in the district.

Acokanthera venenata
Apodytes dimidiata
Buddleja salicifolia
Burchellia bubalina
Calodendrum capense
Canthium mundtianum
Canthium obovatum
Canthium ventosum
Carissa bispinosa
Catha edulis
Cissus cirrhosa
Clausena inaequalis
Dracaena hookeriana
Embelia ruminata
Encephalartos altensteinii
Eugenia zeyheri
Fagara capensis
Harpephyllum caffrum
Heeria mucronata
Heteromorpha arborescens
Jasminum angulare
Mimusops obovata
Ochna arborea
Ochna atropurpurea
Osyridicarpos natalensis
Pavetta capensis
Plumbago capensis
Podocarpus falcatus
Podocarpus latifolius
Psychotria capensis
Pterocelastrus tricuspidatus
Rapanea melanophloeos
Rhoicissus digitata
Rhoicissus rhomboidea
Rhus legati
Royena villosa
Scolopia mundii
Secamone alpini
Secamone frutescens
Tecomaria capensis
Trichocladus ellipticus
Trimeria rotundifolia
Trimeria trinervis

TYPE NO. 5—DRY FOREST

COMPOSITION

An example of type 5 is to be found at Lenye Forest Station, which has at its lower limits an annual rainfall of about 29 inches. As distinct from the first four, type 5 may be taken as true forest, although a dry variety of it. This is indicated, besides by the points which follow, by the fact that *Turacus corythaix* and *Poicephalus robustus*, both forest birds and absent from the drier types, are well represented here. It is only when one is close enough to distinguish the separate species of trees that one can establish the type to which the forest belongs, but although at a distance there is no difference in appearance between it and the high forest (type 6), its identity can usually be judged by the patches of tree Euphorbias in the neighbourhood outside it, or by a growth of Acacia in clearings and on its margins.

The kloofs are for the most part dry, but some have small streams which run for part of the year and along them are good specimens of forest trees and a few examples of *Xymalos monospora* which is typically absent from this type. Even if the vegetation is open, permanent streams in the immediate vicinity of type 5 do not as a rule have any of the *Combretum salicifolium* which accompanies those in the drier types. As Combretum is a tropical genus, its absence may be bound up with the lower temperatures recorded in type 5 (Tables 5, 6, pp. 11, 12). It has been found to border the streams from the Karroid Broken Veld (as discussed on p. 32) to the lower limit of forest country, and to mark this lower limit with a fair degree of accuracy.

The level of the canopy as a whole is about 40 feet. The average height of all trees as given by the transects is 20 feet, and visibility is more or less the same as in type 4, 20 yards or thereabouts.

Pappea capensis, common in types 2 and 3 and scattered in type 4, drops out here, but a dry character is still manifest from the presence of *Cassine crocea*, *Schotia latifolia*, *Olea africana* and *Dovyalis zeyheri* among the trees and *Plumbago capensis* and *Croton rivularis* among the shrubs. Forest trees are plentiful but from the transect it appears that they are not as strongly represented as the bush and scrub species. *Grewia occidentalis* has the highest frequency of all, and notwithstanding its occurrence in high forest it is more a plant of the dry and hot areas throughout the eastern Cape. A bush in these parts, it takes on the form of a scrambler in the forests. The climbing habit of *Azima tetracantha* which becomes apparent in type 4 is here better developed, and the long straggling branches make their way through loops and characteristic zig-zags to the lower tree-tops where they produce a dense and leafy growth. *Entada natalensis* reaches a diameter of 6 inches and a length of 50 yards. It has many branches that may coil and twist over the forest floor for half their length before ascending to the crowns of the highest trees.

The forest has areas which are a dense tangle of live and dead lianes, in places interwoven and greatly cutting down the light, and often in the form of a low and gloomy arch with the rotted remains of the supporting tree underneath it. These more or less impenetrable piles of trash give a general impression of a brown tangle of vegetation, consisting mostly of stems half an inch thick with about half their number dead. A dense litter of twigs and leaves accumulates, and tree seedlings are absent almost entirely (photograph 21). This is probably because of the dark conditions, for Phillips in his work in the Knysna forests (1931, p. 205) has supported with experimental data his statement: ". . . the absence of regeneration in its various stages, or the poor growth of such regeneration as does exist, is to be attributed to insufficiency of light." There is a negligible amount of undergrowth in such places. Most species of lianes, however, seem to be capable of withstanding this weak illumination and various-sized seedlings may be found in the most deeply-shaded spots.

Except on these dark parts of the forest floor, the undergrowth is thick and consists mainly of members of the *Acanthaceae*, ground ferns, *Plectranthus* spp. and *Asparagus* spp., commonly *Asparagus virgatus*, with grasses where a break in the canopy allows stronger light to penetrate. *Stipa dregeana* is the commonest one and forms a sward in places. *Panicum maximum*, *Panicum deustum* and *Oplismenus hirtellus* occur sporadically (see photograph 22).

There is a deep layer of leaf mould, and fresh litter and fallen trees are rapidly broken down by numbers of saprophtyic fungi which thrive under the fairly humid conditions inside the forest. Among the more conspicuous are *Polyporus gilvus*, *Stereum lobatum* and *Polystictus sanguineus*. Below type 5 they are not noticeable. *Streptocarpus rexii* is commonly found here for the first time, growing on the ground or on the rocks, where with the help of the mosses it covers even vertical faces with a deep blanket of vegetation suitable for the establishment of ferns, *Plectranthus* spp. and small trees.

The following is a list of the lianes and smaller creepers which occur:—

Asparagus spp.
Azima tetracantha
Behnia reticulata
Buddleja dysophylla
Capparis citrifolia
Capparis rudatisii
Cassine tetragona
Ceratiosicyos ecklonii
Cissus cirrhosa
Cissampelos torulosa
Coccinia quinqueloba
Cynanchum sp.
Dioscorea sylvatica
Embelia ruminata
Helinus integrifolius
Jasminum angulare
Kedrostis sp.
Rhoicissus cuneifolia
Rhoicissus digitata
Rhoicissus rhomboidea
Royena sp.
Sarcostemma viminale
Secamone alpini
Secamone frutescens
Scutia myrtina
Senecio angulatus
Senecio deltoideus
Senecio macroglossus
Senecio tamoides

Epiphytes are abundant throughout (photograph 22). The commonest are lichens, leafy mosses, *Polypodium polypodioides* and *Peperomia reflexa*. *Angraecum mystacidii* appears to be absent, but *Polystachya ottoniana* is present in small amounts.

Growing round the lower margins and mingling with the predominating Themeda-Panicum-Digitaria mixture there are often members of the sourveld grasses, with corresponding non-grasses like *Dobrowskya scabra*, *Lobelia erinus* and *Schistostephium* spp. These are found in contact with the upper margin to the exclusion of the typical sweetveld species, and in addition there is a growth of macchia almost invariably, made up of *Cliffortia linearifolia* or, in one of the drier localities, *Passerina filiformis*. These species are below the range of the *Cliffortia paucistaminea* and *Erica brownleeae* which are the fringing species of the higher altitudes.

SUCCESSION

At altitudes up to about 2500 feet the commonest pioneer tree of this type is Acacia. Occasionally clumps of trees may be built up in the open round a nucleus of *Scutia myrtina* or *Azima tetracantha*, but the usual development of forest follows in essentials the pattern described by Bews (1917a)—open grassland becomes invaded by scattered Acacia, which gives protection and shelter to seedling forest trees. The seedlings grow up to form bush clumps, shading and killing the Acacia in the process, and spreading outwards until they merge and form an unbroken community. Without the Acacia the forest would probably spread more slowly than it does. Under a single dying Acacia tree near the forest margin in the hills above Debe Nek the following plants were found:—

Allophylus decipiens
Apodytes dimidiata
Burchellia bubalina
Canthium ciliatum
Canthium obovatum
Canthium ventosum
Carissa bispinosa
Cassine sphaerophylla
Fagara capensis
Gardenia neuberia
Grewia occidentalis
Gymnosporia buxifolia
Gymnosporia nemorosa
Halleria lucida
Jasminum angulare
Ochna sp.
Olea africana
Olea laurifolia
Osyridicarpos natalensis
Pavetta lanceolata
Podocarpus latifolius
Protorhus longifolia
Putterlickia sp.
Randia rudis
Rapanea melanophloeos
Rhoicissus cuneifolia
Rhus legati
Rhus pyroides
Rhus undulata
Royena lucida
Royena simii
Royena villosa
Scolopia mundii
Scolopia zeyheri
Scutia myrtina
Secamone alpini
Secamone frutescens
Trimeria rotundifolia.

This makes a total of 38 species; individuals were so many that it was impracticable to count them. An idea of their number may be gained from the fact that a young four-foot Acacia in this vicinity had 36 separate forest seedlings growing beneath it. In the open grassveld none were seen.

EFFECTS OF GRAZING

If there has been uncontrolled and heavy stocking in type 5, its contrastingly open appearance is striking. Bushes and trees are denuded of every available leaf and even the twigs are chewed. Trees with a single stem are mushroom-shaped, with the lower edges of the branches evenly shorn off at the limit of the animals' reach. Those with a shrubby or denser growth form, and especially those which are in addition thorny, are eaten into the form of a cone. The centre of the bush, being less accessible, has a slightly better chance of growth, but towards the edges the damage becomes progressively more severe, and the constant pruning of all shoots growing outwards forces the growth away from the periphery. Any side branches from the taller central portion are likewise checked until they have been carried upwards into safety. The final growth form is a characteristic hour-glass shape, and the stages are shown in photographs 12 and 13. Similar effects of browsing on tree growth have been reported from Germany by Walter (1927, p. 187).

Different species are grazed without discrimination provided that they are not actually poisonous, and even the poisonous ones do not escape completely. Leaves of *Acokanthera venenata* are occasionally taken notwithstanding their high toxicity (Steyn, 1934, p. 330) and the fact that they have a burning taste (Watt and Breyer-Brandwijk, 1932, p. 142).

The mixed undergrowth gradually disappears until the ground becomes bare except for the covering of litter which has been described under type 4. This stage remains more or less stable until the canopy begins to break down because of the death of the older trees or because of felling. Where the gaps allow sufficient light to reach the ground, a mat of *Cynodon dactylon* and *Sporobolus capensis* is often able to spread, and in time the forest takes on the appearance of a park, with the clean-boled trees widely spaced, a close-grazed lawn, and bushes grotesque in shape through continuous cropping, calling to mind the topiary art of formal gardens. *Senecio juniperinus* is a common weed in bare places, and makes a conspicuous show with its bright yellow heads during mid-summer.

The need of the Native population is for timber and wattles and this causes the more useful trees to be removed first. As the soft and spongy wood of *Cussonia spicata* is of little use (Sim, 1907, p. 230), this tree is saved from the destruction which overtakes the timber trees and its high relative frequency is a feature of the heavily exploited forests.

Under normal conditions the death of a mature tree inside a forest provides a clear space ideally suited to a growth of seedlings of all descriptions, and soon after the establishment of a cover of quick-growing herbs or grass, the young trees make an appearance and a dense stand of saplings grows up. Regeneration in the forests examined was vigorous and adequate even during the 1949 drought, provided that the area was protected from destruction by stock. Examples were numerous in the protected patch on Chulu Ridge 2 miles south of the house at Chatha Forest Station. There are no photographs or analyses to show the appearance of the protected patch when the fence was first put up, but this lack is to a great extent made good by the existence of an unfenced forest half a mile to the south. Both patches belong to type 5 and for practical purposes are identical in size, slope, shape and altitude. When studied with respect to each other they give one the clearest picture possible of how forest can be destroyed by man and his stock. These points are shown in photographs 23–26.

The tree seedlings which are coming up in the glades of the protected forest (mostly *Ptaeroxylon obliquum*, *Brachylaena* sp. and *Buddleja salicifolia*) show that there is a definite tendency for an encroachment of the forest upon the grassland.

TABLE 27

BELT TRANSECT FIGURES

DRY FOREST (TYPE 5)

Area: 4×608 sq. yds.

Stems Listed: 1 inch diameter breast height and over.

Species	Total Stems	Av. Ht.	Av. Diam.	Max. Ht.	Max. Diam.	Per cent Freq.
		Ft.	Ins.	Ft.	Ins.	
Acokanthera venenata ..	2	12	1	12	1	0·24
Allophylus decipiens ..	73	14·6	1·8	25	5	8·66
Azima tetracantha	26	13·3	1·3	40	4	3·09
Brachylaena sp.	2	18	3	24	5	0·24
Buddleja salicifolia	5	30·8	5·2	45	12	0·59
Calodendrum capense ..	2	25	5·5	30	9	0·24
Calpurnia sylvatica	5	12·8	1·4	14	2	0·59
Canthium sp.	3	34·7	3	40	5	0·35
Canthium ventosum	1	15	1	15	1	0·12
Capparis citrifolia	13	24·1	1·6	40	3	1·55
Cassine papillosa	2	12·5	1	15	1	0·24
Cassine sp.	10	16·8	2	25	4	1·19
Celtis kraussiana	12	26·9	4·9	60	24	1·42
Chaetacme aristata	81	14·8	1·9	30	6	9·62
Clausena inaequalis	11	13·6	1·9	24	4	1·31
Cryptocarya woodii	12	19·1	2·8	30	6	1·42
Curtisea faginea	1	40	6	40	6	0·12
Cussonia spicata	19	32·3	10·3	40	36	2·25
Dovyalis zeyheri	3	31·7	4·3	40	6	0·35
Dracaena hookeriana ..	31	5·4	1·1	8	2	3·68
Embelia ruminata	1	24	2	24	2	0·12
Entada natalensis	11	29·3	1·7	35	2	1·31
Euclea sp.	40	18·4	2	50	4	4·75
Eugenia zeyheri	30	13·7	1·8	40	8	3·56
Fagara davyi	4	20·8	2·5	30	4	0·47
Gardenia neuberia	4	14	1	14	1	0·47
Gelonium africanum ..	3	16·7	1·3	24	2	0·35
Grewia occidentalis	95	15·4	1·3	30	3	11·28
Gymnosporia nemorosa ..	36	17·1	2·9	24	9	4·27
Gymnosporia peduncularis ..	6	20	2·7	30	7	0·71
Hippobromus pauciflorus ..	48	17·9	1·6	25	4	5·69
Maerua racemulosa	1	8	1	8	1	0·12
Olea africana	2	21·5	5·5	25	9	0·24
Olea capensis	2	22	3·5	26	6	0·24
Olea laurifolia	6	25	1·8	30	2	0·71
Pavetta lanceolata	1	12	1	12	1	0·12
Pleurostylia capensis ..	5	16·4	4	24	11	0·59
Ptaeroxylon obliquum ..	9	17·4	1·7	24	3	1·07
Putterlickia sp.	11	13·1	1·2	24	3	1·31
Rhoicissus cuneifolia ..	2	32·5	2·5	40	4	0·24
Rhoicissus rhomboidea ..	3	12·7	1·7	14	2	0·35
Rhus legati	10	37	7·6	50	24	1·19
Rhus refracta	31	20·2	3·2	35	8	3·68
Royena lucida	8	18·4	2	35	6	0·95
Royena villosa	7	18·3	1·1	24	2	0·83
Schotia latifolia	37	25·1	6·1	45	24	4·39
Scolopia zeyheri	2	12	1	12	1	0·24
Scutia myrtina	22	27·5	2·1	40	5	2·61
Secamone alpini	1	30	1	30	1	0·12
Secamone frutescens ..	1	18	1	18	1	0·12
Sideroxylon inerme	2	36	4	36	4	0·24
Trichocladus ellipticus ..	79	12·9	1·4	24	5	9·38
Trimeria rotundifolia ..	2	17	1	24	1	0·24
Vepris lanceolata	7	24·8	3·2	40	10	0·12
Totals	843					99·34

TABLE 28

ADDITIONAL SPECIES

DRY FOREST (TYPE 5)

Woody plants (*a*) too small to be listed in the transect
or (*b*) noted outside the transect
or (*c*) noted in the same forest type elsewhere in the district.

Buddleja dysophylla
Burchellia bubalina
Capparis rudatisii
Carissa bispinosa
Cassine tetragona
Cissus cirrhosa
Commiphora caryaefolia
Ekebergia capensis
Encephalartos altensteinii
Ficus burtt-davyi
Halleria lucida
Harpephyllum caffrum
Heteromorpha arborescens
Jasminum angulare
Mimusops obovata
Ochna arborea
Ochna atropurpurea
Pavetta capensis
Pittosporum viridiflorum
Plumbago capensis
Podocarpus falcatus
Pterocelastrus tricuspidatus
Rapanea melanophloeos
Rhoicissus digitata
Rhus pyroides
Teclea natalensis
Trimeria trinervis

TYPE NO. 6—MOIST FOREST

COMPOSITION

Type 6 is found in areas where the rainfall averages about 35 inches and upwards, and in a climate appreciably cooler than in the other woodland types (Table 2, p. 8), the highland macchia excepted. Its lower limits are in contact with the sourveld, or alternatively with macchia made up almost exclusively of *Cliffortia linearifolia*, its upper limits border on sourveld, on *Helichrysum argyrophyllum*, or on macchia of *Cliffortia paucistaminea* or *Erica brownleeae*, according to the conditions prevailing. Here, unless the altitude is below 4000 feet, *Cliffortia linearifolia* is never represented as a community but as individuals only, and is rarely seen even in this form.

As has been previously stated, and as may be seen from Tables 21–30, there are some trees which type 6 has in common with the drier types. In habit however they are often distinct. Where found at all under the moist conditions of the forests, the straggling bushes and the stubby, gnarled and branching trees of the drier localities occur as lianes and as slender clean-stemmed trees respectively. This has been mentioned in the descriptions of types 4 and 5 and the difference in habit of *Scutia myrtina* is shown in photographs 13 and 14. Their size is also much greater, and sometimes the leaves are so much larger as to give the impression that different species are involved. *Gymnosporia buxifolia*, thorny and shrubby in the lowlands, is found on the forest margins and on the slopes above them in the form of an umbrella-shaped tree, with spines small and few by comparison.

The height of the canopy is about 50 feet, rising in places to 70 and over where the best specimens of Podocarpus and *Olea laurifolia* grow. Sim (1907, p. 4) records heights of 100 feet for the Amatole trees, and in this connection uses the word "average", but clearly in a loose sense.

As an indicator tree in this forest type, *Xymalos monospora* is the most reliable and widespread. *Cunonia capensis*, *Strophanthus speciosus* and *Englerodaphne pilosa* are also confined to type 6 but occur patchily and are easily missed in consequence. A peculiar feature of these forests is the enormous quantity of *Trichocladus ellipticus* in them. Transect figures show that nearly half the stems measured were of this species, and because it is a slender tree, there were in addition very many too small to be included in the transect figures. Their number does not strike one until a count is made, for one's attention is liable to be taken up disproportionately by the larger and more striking trees. Trichocladus has wood of an unusually brittle nature which snaps easily during storms. Many of the larger specimens are in consequence broken about the top, and the tree does not pierce the forest canopy.

The undergrowth is unmistakably different from that of type 5 in spite of the fact that the *Acanthaceae*, as in the drier types, make up a large proportion of it. Ferns are richer in numbers and species and are usually common throughout. Even the various species of Adiantum may here be seen growing away from the stream banks which are their normal habitat in type 5. Conspicuous and common plants are *Plectranthus krookii* and *Plectranthus fruticosus*, in places intermixed and forming tangles of sappy growth, others of about the same height being *Galopina circaeoides*, *Euphorbia epicyparissias*, *Euphorbia kraussiana*, *Desmodium scalpe* and *Thalictrum* spp. In undisturbed forest they make a rather even covering which hides the quantities of old and rotting wood on the floor, and its inequalities. Grasses and sedges are of minor importance. The following species are those most often seen: of the grasses, *Stipa dregeana*, *Oplismenus hirtellus* and *Brachypodium flexum*, and of the sedges *Cyperus teneriffae* and *Schoenoxiphium sparteum*. There is a ground layer of low-growing plants as well, including typically *Hydrocotyle asiatica*, *Diclis reptans*, *Sanicula europaea*, *Polygala confusa* and *Streptocarpus rexii*. A layer of mould forms an unbroken covering to the soil. The only really conspicuous flower in the shady parts of the forest floor is *Streptocarpus rexii*. *Nerine alta* can also grow in poor light and is showy when it comes into bloom in the late summer, but it favours the more open parts where it adds variety to the patches of *Zantedeschia aethiopica*, *Kniphofia* spp. and *Ornithogalum lacteum* which are also plants of the more open situations.

Visibility is as a rule poor, and may be judged from photograph 27. Mr. R. A. Hoyle is standing about one yard to the left of the large Podocarpus bole on the right edge of the picture, and is less than ten yards from the camera.

Moles and earthworms show their presence by their mounds and castings in all parts of the forest. Bordered as the forests are by the Native settlements, it follows naturally that game is almost absent through poaching by men and dogs, and it is only the birds and monkeys which remain plentiful. Characteristic birds are *Poicephalus robustus*, *Columba arquatrix* and *Turacus corythaix*. The habits of the last two have a bearing on seed dispersal in the forests and have been the subject of papers by Phillips (1927 and 1928b). During the summer one is seldom out of earshot of the call of *Chrysococcyx cupreus* which abounds in all the high forests of the Amatole range. According to a note in the Albany Museum guide (1931, p. 164) one may expect to hear it roughly between September and February. Gill (1945, p. 108) states that it has been described as "the most dazzlingly beautiful bird in Africa", but it is shy and seldom seen. Essentially a bird of the dense forest only is *Motacilla clara*, which frequents "rocky streams in thick bush or forest and apparently never leaves such sheltered spots" (Albany Museum guide, 1931, p. 91). It is rare in the Keiskammahoek district.

The saprophytic fungi are plentiful and play their part with the woodpeckers and boring insects in breaking down the dead trees into the soft and crumbly humus mentioned previously.

There is no lack of surface water, for perennial streams run down all the larger kloofs. *Ilex mitis* grows only on their banks or in the streams themselves, and is in this respect unique amongst the trees of the Amatole forests, for the others, although they may and often do grow next to Ilex in the streams, grow equally well elsewhere, which indicates that the presence of an unlimited water supply is not a necessity to them. Most of the water comes originally from the mountain slopes above the present timber line but occasionally it has its source in marshy areas inside the forest. If they are level or nearly so they become waterlogged, and connected with this more or less stagnant water is some factor lethal to trees, so that even *Ilex mitis* cannot live in such places. There is nevertheless a strong and unceasing tendency on the part of the trees to invade the area and if there is any suitable change in the conditions prevailing they readily do so. They grow with varying success but sooner or later most succumb, and the consequence is that these open spaces are dotted with skeleton trees which afterwards fall and become half-buried in the existing vegetation.

Where the seepage areas are on a slope and the water is able to flow, tree growth is normal. The ground vegetation then consists of a mixture of hygrophilous bushes, herbs and ferns, *Hypolepis sparsisora* and *Englerodaphne pilosa* prominent among them, and if seen along the margins of the forest roads a sign of a sticky patch and of bad driving conditions in wet weather. A species of Impatiens is also common, growing best in saturated ground, often in company with carpets of *Selaginella kraussiana* and *Lycopodium clavatum.* On the margins of the running water sedges are frequent but inconspicuous, barring *Carex petitiana* which has culms up to three feet long and large nodding inflorescences.

The Impatiens which as been mentioned, common and widespread in the eastern Cape, has for many years been known as *Impatiens capensis* Thb., but according to Burtt (1938, pp. 161–3) the name is not valid for the South African species, and there is as yet no other name which may be substituted. There is a specimen from Keiskammahoek in the National Herbarium, Pretoria (Story No. 3261).

The level bogs referred to bear a distinct vegetation and are discussed on page 100.

SUCCESSION

Acacia karroo is not found with this type. The commonest pioneer tree is *Rapanea melanophloeos,* which, while a member of the interior of the forest, is also well able to grow in the open and provide shelter for those species less tolerant than itself. It cannot however stand the hotter conditions which suit Acacia, nor can Acacia thrive where Rapanea grows, and the transition between types 5 and 6 is often clearly shown by the distinct boundary between these two species on the forest outskirts. The dividing line is usually accentuated by the open appearance of the mixed grass and shrubs between the Acacia, and the dense growth of *Cliffortia linearifolia* in the environs of type 6. Different trees may assume the functions of pioneers sporadically, and, as far as can be seen, by chance, and Rapanea certainly does not have the great preponderance over other associated pioneers that Acacia has in the drier parts. The following list gives an idea of the variety of forest trees which are habitually able to grow in the open under the milder climatc conditions which prevail in the neighbourhood of the higher forest types:—

Apodytes dimidiata
Brachylaena sp.
Buddleja salicfolia
Buddleja salvifolia
Burchellia bubalina
Calpurnia sylvatica
Canthium ciliatum
Carissa bispinosa
Cassinopsis ilicifolia
Cussonia spicata
Dovyalis zeyheri
Gymnosporia buxifolia
Halleria lucida
Lachnopylis floribunda
Metalasia muricata
Osyris compressa
Pittosporum viridiflorum
Podocarpus falcatus
Podocarpus latifolius
Rapanea melanophloeos
Rhamnus prinoides
Rhus dentata
Rhus legati
Rhus pyroides
Royena lucida
Scutia myrtina.

Calpurnia sylvatica usually forms definite consocies and occasionally *Rapanea melanophloeos* shows this tendency also. With these exceptions the trees are not grouped into any recognisable pattern but grow as individuals, sometimes evenly mingled and sometimes with one or two species more numerous than the others.

Where the forests are not fenced, the young trees, under the present conditions of stocking, are continually suffering setbacks from the damage done by grazing animals. Because of this, it is the thorny bushes which are least molested, and which consequently offer the most favourable conditions to the growth of tree seedlings in their shelter. Clean-boled or unarmed trees may indeed have entirely the opposite effect from the theoretical one of acting as nurses to a denser tree growth, for as they grow taller and shadier, so do the stock tend increasingly to congregate beneath them in the heat of the day, with the result that existing seedlings are destroyed by trampling and no new ones are able to grow. This is shown in photograph 29. On the other hand, a 5-foot *Carissa arduina* in the same locality in which the photograph was taken had the following small trees growing under protection:—

Grewia occidentalis
Pittosporum viridiflorum
Ptaeroxylon obliquum
Randia rudis
Rapanea melanophloeos
Rhamnus prinoides
Rhus legati
Scutia myrtina.

To summarise: trees growing in the open are theoretically and potentially the fore-front of an advancing area of forest, but where stocking is heavy this function falls away unless the trees in question are armed or shrubby. There are few such trees in type 6. The transect figures show that they make up only 12·54 per cent of the total, in contrast with 44·06 per cent in type 2. That is why one finds that heavy stocking tends to increase the woody growth in scrub, and decrease it in the forests (see photograph 28).

TABLE 29

BELT TRANSECT FIGURES

MOIST FOREST (TYPE 6)

Area: 4× 608 sq. yds.

Stems Listed: 1 inch diameter breast height and over.

Species	Total Stems	Av. Ht.	Av. Diam.	Max. Ht.	Max. Diam.	Per cent Freq.
		Ft.	Ins.	Ft.	Ins.	
Apodytes dimidiata	3	31·6	8·6	50	24	0·37
Burchellia bubalina	6	20·3	2·5	30	4	0·74
Calodendrum capense	2	75	27	80	36	0·25
Calpurnia sylvatica	1	25	2	25	2	0·12
Canthium ciliatum	12	16·5	1·4	24	2	1·47
Canthium obovatum	4	25·5	2·5	36	4	0·49
Canthium sp.	3	18·6	1·6	20	2	0·37
Cassine papillosa	4	17	1	20	1	0·49
Celtis kraussiana	9	43	12·4	65	24	1·11
Cryptocarya woodii	9	22·2	2	30	5	1·11
Curtisea faginea	11	42·7	9·8	60	36	1·35
Dovyalis lucida	7	14·4	1·1	20	2	0·86
Dovyalis zeyheri	1	45	18	45	18	0·12
Eugenia zeyheri	1	8	1	8	1	0·12
Fagara davyi	19	36·4	5·4	60	18	2·34
Gardenia neuberia	34	12·7	1·6	20	3	4·18
Gardenia rothmannia	8	25·9	3·2	50	6	0·98
Grewia occidentalis	1	30	1	30	1	0·12
Gymnosporia acuminata	5	30·2	5·4	36	9	0·62
Gymnosporia deflexa	3	22	2·3	30	3	0·37
Gymnosporia peduncularis	4	29·5	4·5	40	10	0·49
Gymnosporia nemorosa	17	20·2	2·3	30	6	2·09
Halleria lucida	3	22	8·3	30	12	0·37
Ilex mitis	1	30	3	30	3	0·12
Kiggelaria africana	8	38·6	8·1	50	12	0·98
Mimusops obovata	4	18	1·5	24	2	0·49
Ochna arborea	21	17·6	2	60	9	2·58
Olea capensis	4	26	3	36	5	0·49
Olea laurifolia	56	25·2	3·7	90	36	6·88
Pavetta lanceolata	1	10	1	10	1	0·12
Pittosporum viridiflorum	1	8	1	8	1	0·12
Pleurostylia capensis	8	27·2	2·7	36	6	0·98
Podocarpus falcatus	9	49	24·7	100	60	1·11
Podocarpus latifolius	20	38·4	12	100	60	2·46
Psychotria capensis	1	30	3	30	3	0·12
Ptaeroxylon obliquum	1	48	12	48	12	0·12
Rapanea melanophloeos	5	18	1·4	24	2	0·62
Rhoicissus cymbifoliolus	1	25	1	25	1	0·12
Rhus legati	16	36·2	5·8	55	24	1·97
Rhus lucida	2	12	1	12	1	0·25
Royena lucida	13	23·8	2·6	40	6	1·60
Scolopia mundii	4	29·2	3·5	40	7	0·49
Scolopia zeyheri	6	21·7	1·7	40	3	0·74
Scutia myrtina	10	43	3	60	6	1·23
Secamone alpini	2	35	1	40	1	0·25
Trichocladus ellipticus	369	20·2	2·1	55	9	45·33
Vepris lanceolata	14	23·6	2·9	40	18	1·72
Xymalos monospora	70	29·6	6·8	60	24	8·60
Totals	814					100·02

Table 30

ADDITIONAL SPECIES

MOIST FOREST (TYPE 6)

Woody plants (*a*) too small to be listed in the transect
or (*b*) noted outside the transect
or (*c*) noted in the same forest type elsewhere in the district.

Acokanthera venenata
Allophylus decipiens
Andrachne ovalis
Bowkeria sp.
Brachylaena sp.
Buddleja dysophylla
Buddleja salicifolia
Buddleja salvifolia
Canthium ventosum
Carissa bispinosa
Cassine tetragona
Cassinopsis ilicifolia
Chaetacme aristata
Choristylis rhamnoides
Cissus cirrhosa
Clausena inaequalis
Commiphora caryaefolia
Cunonia capensis
Cussonia spicata
Dovyalis rhamnoides
Dracaena hookeriana
Embelia ruminata
Encephalartos altensteinii
Englerodaphne pilosa
Ficus capensis
Gardenia thunbergia
Gelonium africanum
Heteromorpha arborescens
Hippobromus pauciflorus
Jasminum angulare
Lachnopylis floribunda
Maerua racemulosa
Ocotea bullata
Osyridicarpos natalensis
Pavetta capensis
Pterocelastrus tricuspidatus
Putterlickia sp.
Pygeum africanum
Rhoicissus capensis
Rhoicissus cuneifolia
Rhoicissus digitata
Rhoicissus rhomboidea
Rhus dentata
Rhus pyroides

TYPE NO. 7—MACCHIA

GENERAL

In The World As A Whole

Macchia is perhaps best known from the Mediterranean region of Europe, where it is the characteristic vegetation. During World War II it gave the French form of its name to the Resistance movement, and although in this way millions became acquainted with the word, probably the greater part of the English-speaking ones had no idea of its derivation. There are various objections to the term *macchia*, but it is probably better known than the South African term *fynbos*, and is accordingly used by preference in this paper. In spite of the fact that its component species differ from place to place, one is justified in calling it macchia as long as its growth form is unchanged, for the word refers only to its growth form and not to its floristic composition. In South Africa it is the dominant formation of the winter-rainfall region of the south-western Cape Province. Besides in the Mediterranean region and in the western Cape, a similar formation of sclerophyll shrubs is found:—

1. In the highlands of tropical America, in places where the soil is apt to become frozen (Beard, 1944, p. 133).

2. In Java, on the mountain Pangerango (Schimper, 1903, pp. 724-5). The plants here are chiefly *Anaphalis javanica* (*Compositae*), which forms an Alpine woodland at an altitude of about 3000 metres (9840 feet). Schimper's photograph of this woodland could pass easily for one of the highland macchia at Keiskammahoek. His description applies equally well:—"Beyond the elfin-wood, almost completely covering the summit of the mountain, is a dense mass of shrub, taller than a man, with small,

Table 31

SUMMARISED FIGURES FOR HALF-ACRE TRANSECTS

Type	Species	Stems	Per cent Spiny Stems	Maximum Height	Average Height	Maximum Diameter	Average Diameter
2	21	295	44·1	14	8·0	8	2·1
3	42	683	28·1	25	12·5	24	2·1
4	39	882	34·8	30	15·9	18	2·8
5	53	842	23·9	60	20·2	36	2·6
6	48	814	12·5	100	27·9	60	4·9

or at most middle-sized, leaves which are all xerophlious in structure . . . The dominant shrub is the woolly *Anaphalis javanica*, which growing socially, often entirely excludes all other woody plants. . . Here and there the scrub on the summit is interrupted by Alpine steppe, the chief constituents of which are narrow-leaved, short grasses." Like the Amatole range, this region has a summer rainfall.

3. In Uganda. On the high mountains where trees are absent, Ericaceous species may form a subalpine community (Snowden, 1933, p. 24), sometimes associated with *Protea abyssinica* and *Anthospermum pachyrrhizum* (Thomas, 1943, pp. 162–3). The boundary between this formation and the forest below it is at about 2400 metres (7870 feet).
4. In Tanganyika, where small groves of *Erica arborea* grow near the Alpine zone of Kilimanjaro (Schimper, 1903, p. 738).
5. In Australia, the sclerophyll leaf being here typical of the Mediterranean climate of the south-west, but occurring also in desert scrub and in regions with a rainfall of 40 inches (Bews, 1927, p. 76; Wood, 1934, p. 70).
6. In the British Isles "on exposed high-lying peat moors, which are not too wet, but where trees cannot grow, it is the climatic climax" (Tansley, 1923, p. 55).
7. On mountain tops throughout the Union of South Africa and the adjacent territories (Bews, 1916, 1917b; Liebenberg ms.; Levyns, 1938; Rennie, 1935; Weimarck, 1934).
8. Above the forests on the Pacific islands of Juan Fernandez and Desventuradas (Skottsberg, 1945).
9. In parts of the Falkland Islands (Skottsberg, 1945).
10. In parts of California (Bews, 1927, p. 76).
11. In parts of Chile (Bews, 1927, p. 76).

There is general agreement among those authors who touch on its ecology that macchia is a more xerophytic type of vegetation than forest, and its leaf structure supports this view (see page 125). Its presence in the Mediterranean region and in others where the climate is similar may be explained by the fact that such regions are physiologically dry (Maximov, 1929, p. 266), and its presence in the other places mentioned may be attributed likewise to drought, caused either directly, by lack of rain, or indirectly, by the factors which come into play in cold or windy climates and at high altitudes. The matter is discussed in Chapter 4.

In the Eastern Cape Province in Particular

In the eastern Cape, it extends westwards along the mountains beyond the Amatole range (where *Cliffortia* spp. and *Erica brownleeae* are co-dominant) as far as the Bosberg, which overlooks Somerset East. The Bosberg variant strongly resembles in growth form and colour the Amatole macchia, and floristically also the two are very nearly related. The dominant bush on the Bosberg is a species of Erica, near *Erica rupicola*. Notes by H. Bolus and L. Kensit on Weale's specimens from Bedford in the herbarium of the Albany Museum indicate that it is probably a new species, differing from *Erica rupicola* in habit, size of corolla and pubescence of ovary. As far as is known, there are no other records of it than those from Somerset East and Bedford. With the Erica are the usual smaller communities and scattered specimens of *Metalasia muricata*, *Restionaceae*, *Aspalathus* spp., *Pteridium aquilinum* and the like. The *Proteaceae* are represented by *Protea macrophylla*. Neither of the Amatole species (*Protea lacticolor* and *Protea multibracteata*) was observed. The vigorous growth of Erica seedlings in burnt areas indicates that the two forms of macchia are probably alike even in behaviour (see pages 84–5)

A peculiar feature of *Erica brownleeae*, and the Bosberg and Bedford species, is that both should be known only from the narrow limits of less than 50 miles of mountain country (see page 81). They may owe their presence to one of the following possibilities:—

1. Parent communities as yet undiscovered.
2. Parent communities since become extinct because of disease or unfavourable climate.
3. Evolution from other species of Erica.

Since the Cape has been well explored botanically, No. 1 is unlikely. As for No. 2, it is virtually inknown for a species to be destroyed by disease, and minor climatic changes also would be likely to result not in annihilation but, in order, in the death of the plants in unfavourable habitats, the death of old and weak plants, and the dwarfing of the later generations (Clements, 1934, p. 44). Major climatic cycles, according to the evidence presented by Smuts (1932) and by van Riet Lowe (1938), are to be measured in thousands and tens of thousands of years. They alone are likely to have caused the destruction of whole plant populations, so complete that no trace of them remains. As for No. 3, the evolution of a species, unless occurring through a sudden mutation, is a process which in respect of time may dwarf even the climatic cycles (Wells, Huxley and Wells, undated, p. 274). Zeuner (1949, p. 251) quotes the palaentological evidence of various authors to show that it usually takes 500,000 years of evolution before an organism is by general agreement classified as specifically distinct from its ancestral form, and the lowest estimate of the authorities mentioned by Riley (1950) is a few thousand years.

Together with the occurrence of macchia on so many of the Union's mountains, these points suggest that macchia is an ancient and normal vegetation type on the Amatole range.

Its general appearance and characteristics having been described by Bews (1929, p. 11); Adamson (1929, p. 16); Pole Evans (1922, p. 49) and others, the giving of a broad picture of the formation as a whole would be unnecessary repetition. What follows will be a more detailed discussion with particular reference to Keiskammahoek.

The plants making up the local macchia are as a rule compact, unarmed, dark green bushes, seldom more than 10 feet in height, profusely and rigidly branched and with ericoid leaves, and the different genera and species may be superficially so much alike that persons not well acquainted with it sometimes make the mistake of thinking that only one species is present. It is not found in places where the average annual rainfall is below 25 inches, but may be expected in any where the rainfall is above this figure, near the 25-inch isohyet in the form of clumps and isolated bushes, and becoming dominant only near the 30-inch isohyet. Its rainfall requirements thus coincide very nearly with those of the sourveld, which in this district it accompanies almost invariably (see Chapter 3). It is never found in the sweetveld. It is made up of three main communities, namely the *Cliffortia linearifolia*, the *Cliffortia paucistaminea* and the *Erica brownleeae* communities. The first community will be considered separately, the remaining two have so much in common that they are most conveniently treated under one heading. To avoid tedious repetition, specific names will be omitted unless the omission gives rise to ambiguity.

THE *CLIFFORTIA LINEARIFOLIA* COMMUNITY

REQUIREMENTS

Dominated by *Cliffortia linearifolia*, this variety of the macchia is the shortest and most uniform of the three. The bushes do not grow more than about 4 feet high, scattered in the early stages of their invasion into grassland but forming a very dense cover when they are well established. They smooth the irregularities of the ground under a thick olive-green blanket, broken only by the occasional clumps of trees, the cattle-tracks and the roads. The community does not extend much over 4000 feet at Kieskammahoek, reaching its altitudinal limit on the plateau below and to the south-west of West Peak Pirie (4180 feet). Above 4000 feet, *Cliffortia linearifolia* occurs as widely-spaced individuals and not as a community; there is, however, no *lower* limit to communities of it in the eastern Cape, provided the rainfall is adequate. Further north "it occurs in an isolated locality in the Inyanga district of S. Rhodesia, where, according to my own experience, it does not go lower down than 1700 metres (about 5500 feet)". (Weimarck, 1934, pp. 55–6). Doubtless it is prevented from extending its range downwards because of the higher temperatures of the Rhodesian lowlands.

Its requirements for rainfall and altitude are constant for the eastern Cape as a whole, as the following examples show. In those parts of the Albany and Bathurst districts which have a rainfall of about 25 inches, small communities are found in seepage areas, sandy patches and along the edges of roads, where there is a better supply of soil moisture (see pages 32 and 104). Near Collingham Tower, however, where the rainfall is over 30 inches, it is not limited to the moist localities but will grow anywhere in the grasslands. Photograph 30 shows its luxuriant growth in this area. On the Fort Fordyce Forest Reserve and the surrounding highlands of the Adelaide and Fort Beaufort districts (altitude between 3500 and 4000 feet, rainfall 30 inches and over) it is common and beginning to encroach upon the grasslands. West of Fort Fordyce the higher altitude of the mountains seems to be against it. There are a few bushes in the Forest Reserve in the Kaga Mountains north of Bedford (4000 feet and over) and it appears to be absent completely from the Bosberg, Somerset East (5325 feet). On the lower intervening hills round Cookhouse and Daggaboers Nek the altitude is suitable but the rainfall map shows that the rainfall is inadequate, and here it is likewise absent.

Probably bound up with its climatic and rainfall requirements is its tendency to grow better where the aspect is south or south-east. This may be masked by other conditions, so that it is in places indifferent to the aspect, but the *general* truth of the statement is apparent from the fact that in any particular spot it often grows on the mesocline and avoids the xerocline, and that it never grows on the xerocline in preference to the mesocline. It is strongly light-demanding and is not found inside the forests. On the southern margin of the forests where dense shade is cast, it is also not able to grow, or grows in a divaricate form which is positively phototropic. It is more tolerant of seepage areas than *Cliffortia paucistaminea* and *Erica brownleeae*, but although often occupying the low-lying ground which they will not, it avoids any places periodically flooded. It does not for example grow on the bottoms of the *debe* hollows (pages 152–3 and photograph 31) except where they have channels to drain the rainwater away.

PROPAGATION

The plants flower abundantly and it appears that the seed may be produced at any time of the year, for quantities have been collected during January, March, April, June, July, August and November. This, however, requires further investigation, because the seed is not shed as readily as that of *Cliffortia paucistaminea*, and for this reason the collections may have included old seed. The percentage germination has not been established because the seed has so far consistently failed to germinate in the laboratory. At various seasons, attempts have been made with freshly collected and stored seed in soil and on filter paper without result. Weimarck (1934, pp. 161–2) observed that the seed of the species he investigated quickly lost its germinating power. This appears to be the only explanation of the failure of the seed in the tests mentioned, for under natural conditions it germinates well, and at any time of the year provided that it is not cast in deep shade. The dense nature of the bushes themselves and the thick layer of trash which accumulates below them greatly reduce the light at ground level, and in such places no seedlings are to be found, nor, for the same reason, will they grow under a matted accumulation of old grass. But they will germinate and grow even in a dense sward if the grass is short, the reason probably being that short grass intercepts less of the light. There can be no question of an improved water supply in such cases because grass kept short and vigorously growing depletes the soil water more quickly than a rank cover where growth is slow or at a standstill (Theron, undated). There is a slight but definite tendency for a better crop of seedlings to be produced in the bare spaces among the grasses, noticeable not so much where the soil is compact as where it is loose and friable. Ideal conditions are provided by molehills, often large and plentiful in the sourveld (photograph 32). Judging from this, and from its behaviour in the Albany district (photograph 30), one would expect it to be a rapid invader of any abandoned lands in parts where supplies of seed are forthcoming, but photograph 33 shows that this may not happen at Keiskammahoek.

EFFECTS OF GRAZING

If there is an abundance of grass, Cliffortia is avoided by stock and is able to flower and set seed unchecked, but the strong competition from the grass ensures that its spread is a very slow process. With heavier stocking the grass cover is no longer able to hinder the establishment of Cliffortia seedlings, this causing a spreading of the community, slow at first but accelerating as more bushes mature and contribute their share to the seed supplies. This rate of stocking, heavy enough to keep down the grass but not so heavy as to hamper the Cliffortia, provides ideal conditions for the establishment of a dense community. If the rate of stocking is now increased, the animals can make little impression on the stout twigs of the fully-grown bushes, and the result is merely the destruction of the sward, and a slight pruning of the Cliffortia. It is not practicable by controlled grazing alone to convert to grassland areas dominated by Cliffortia. It is necessary to get rid of the Cliffortia first by mechanical means or by burning; then, *when the grassland has been re-established*, the Cliffortia may be kept down by controlled grazing. The land must be very heavily stocked until the grasses are grazed short and the cattle become hungry enough to eat any new growth of Cliffortia that takes place. When the land has been evenly and closely grazed, a period of rest must follow. Such a grazing system does not keep the sward entirely free from it, but it does ensure that the Cliffortia receives no preferential treatment. It is denied the chance of growing into a bush and assumes the form of a dwarf shrublet at the same level as the sward surrounding it. The amount of seed produced by these shrublets is insignificant. After the resting period the cattle will encounter the new shoots while they are still young and sappy and will eat them under the incentive of nothing more than a healthy hunger. Certainly prolonged starvation will not be needed, for *Cliffortia linearifolia* is palatable by comparison with *Cliffortia paucistaminea* and *Erica brownleeae*. The end result is that this plant will make up a proportion of the sprinkling of non-grasses normal in any grassland, and will not spread other than extremely slowly.

The practicability of this method is amply demonstrated at Keiskammahoek, and is shown in photographs 34 and 35. In each photograph the open grassland is heavily and continuously grazed and the part under Cliffortia is grazed lightly by cattle almost exclusively. Close examination of the grassland shows that Cliffortia is present there also, but unimportant in its effect as a detrimental constituent of the pasture. The treatment of the grazed parts shown in the photographs, however, falls short in that there has been no resting period for them up to the present time. They are now beginning to deteriorate according to the pattern described in the chapter on grasslands, and a system of rotation is urgently necessary.

Fenton (1934) gives an account of a parallel case in pastures in Devonshire, which are invaded by heath and other woody shrubs wherever there is light selective grazing. On 26th July, 1946, Mr. J. P. H. Acocks drew my attention to a similar state of affairs in the sourveld at the top of MacKay's Nek, 20 miles from Queenstown on the road to Lady Frere, pointing out that because of heavy grazing no grass had been unduly weakened at the expense of another, and that in parts more lightly grazed, palatable grasses are apt to be eradicated and unpalatable ones to increase.

EFFECTS OF BURNING

Burning will normally kill Cliffortia except where the bushes are spaced too widely and the grass too closely grazed to allow a hot fire to develop. Under these conditions the bushes readily sprout again from a cluster of shoots at the base of the stem. Although searches have been made for sucker regeneration, none has so far been found. In respect of burning it appears more resistant than *Erica brownleeae*, for it has been seen sprouting, after a fire, in places where the Erica bushes were dead without exception. As a method of control, therefore, burning would be useless if half-heartedly done. A fierce blaze is required, and a sparse growth of Cliffortia would need to be protected until the intervening grasses had made growth enough to provide the necessary fuel. As seedlings come up in abundance in burnt areas, burning would have to be carried out more than once before the land could be expected to remain reasonably clear.

SUCCESSION

At Keiskammahoek it appears that with few exceptions the sourveld pastures below 4000 feet change in the natural course of succession to a woodland community. This is shown by the way in which areas of Cliffortia where protected do not revert to grassland but remain under Cliffortia, and by certain definite signs that Cliffortia increases with protection. These are firstly the presence of seedlings and young plants, and secondly that the mature bushes are able to grow above the grasses (with certain exceptions to be discussed shortly) and kill them by casting a shade too deep for them to live in. Grass tufts under vigorous Cliffortia bushes are as a general rule either dead or moribund, and indicate by this fact that they represent a stage in the succession lower than the Cliffortia community. The increase in Cliffortia takes place very gradually in a protected area, for reasons already given; nevertheless tufts of dead grass do finally rot away and the activities of earthworms, moles, field-mice and rats contribute also to the production of loose open ground where the seedlings can obtain a foothold.

All the evidence so far collected points in the same direction, namely that Cliffortia also, although successionally more advanced than the grasslands, is still not a climax community. The succession advances through a slow influx of *Cymbopogon marginatus* and *Miscanthidium capense*. These tall grasses, indiscriminately known as Tambookie, are the exceptions mentioned, for they are not suppressed by the Cliffortia, but can grow well even where it forms the densest stands. Apparently *Cymbopogon marginatus* at least can become established in very dim light, for it may be seen growing up through the Cliffortia bushes and flowering above them. A good example of a Tambookie area lies to the south of the right of way between Wolf Ridge and the plateau above Lenye Forest Station, about 300 yards east of Forestry Department beacon 126. It is protected by a fence on one side and by a steep ravine on the other, and the absence of cropped grass, of paths, and of droppings all prove that it is seldom disturbed. On the other hand, there are abundant signs of trespassing stock in the glades shown in photograph 34, where all grasses, Tambookie included, are held in check by grazing and trampling, and Cliffortia has undisputed dominance. Another area of Tambookie is on the plateau north of Debe Nek. It is on the margin of a piece of fenced land which is used for growing crops and is hence rarely grazed. There is little Cliffortia within the enclosure. Outside, there is the most luxuriant Cliffortia in the district. One may infer that this community would also go to Tambookie if protected, and the history of the plateau supports this view. There is a coloured woodcutter living here who has known this part since he was a boy of ten or so. He states that in 1900 there were a few Cliffortia bushes next to his family's hut, and that the rest of the country, except where the forests were, was tall Tambookie which extended over his head. It used to be burnt yearly by officials of the Forestry Department. This was undoubtedly what kept the vegetation at the grassland stage (see page 90).

The Cliffortia and Tambookie finally give way to a tangled mixed vegetation, taller and difficult to penetrate. Besides many young forest trees and a scattering of the sourveld grasses, these plants are common:—

Anthospermum lanceolatum
Buchenroedera multiflora
Calpurnia sylvatica
Cymbopogon marginatus
Leonotis leonurus
Miscanthidium capense
Plectranthus calycinus
Psoralea pinnata
Psoralea spicata
Pteridium aquilinum
Rhamnus prinoides
Senecio juniperinus
Syncolostemon densiflorus
Watsonia sp.

This stage leads directly to high forest.

A system of controlled grazing which stops the spread of Cliffortia will naturally check the growth of trees as well, but any system, or lack of system, which allows Cliffortia to spread will probably end in the establishment of some type of forest. At the present time, forest is developing in the macchia of the uncontrolled plateau north of Debe Nek, the young trees being for the most part still too small to extend above the macchia but apparent in scores to anyone who walks through it. The following seedlings are represented:—

Brachylaena elliptica
Buddleja salicifolia
Calpurnia sylvatica
Canthium ciliatum
Cassine sp.
Clematis brachiata
Dovyalis zeyheri
Fagara capensis
Halleria lucida
Podocarpus latifolius
Rapanea melanophloeos
Rhus dentata
Rhus legati
Rhus pyroides
Rhus undulata
Royena lucida
Royena simii
Scolopia flanagani
Scolopia zeyheri
Scutia myrtina
Secamone alpini
Strophanthus speciosus.

Whether or not forest is the climax on *all* the treeless land in the *Cliffortia linearifolia* zone has not yet been established with certainty. The relationship is discussed further, in a general way, on pages 92–5.

THE *CLIFFORTIA PAUCISTAMINEA* AND *ERICA BROWNLEEAE* COMMUNITIES

CHARACTERISTICS AND REQUIREMENTS

The detailed description of *Cliffortia paucistaminea* is to be found in the monograph by Weimarck (1934, pp. 64–5). It is a compact dark green bush growing to a height of 5 or 6 feet and bearing crowded half-inch needle leaves. In quantity it does not at Keiskammahoek extend below an altitude of 4000 feet; above 4000 feet there is no altitudinal limit to it in the district for it grows in profusion up to the peaks of the Hogsback (6360 feet). It has not been seen in the Somerset East or Graaff-Reinet mountains but is common on the Kaga range north of Bedford (photograph 36). It has been recorded only from the Cape Province, Basutoland and Natal, between George in the west and Nkandhla in the east. *Cliffortia linearifolia* extends from George to Inyanga, Southern Rhodesia, and in the eastern Cape at any rate is never dominant above 4000 feet. It is interesting that the local altitudinal relation between these two Cliffortia communities should have a parallel in their latitudinal distribution. Possibly *Cliffortia paucistaminea* is better suited to low temperatures than *Cliffortia linearifolia.*

Erica brownleeae is decribed in Vol. 4, Part I of the *Flora Capensis.* It is a bush less branched and less leafy than Cliffortia and of more upright growth. In localities which suit it, it can reach a height of 12 feet, as may be seen at Evelyn Valley. Except for odd plants which may be found as low as 3500 feet, it is a mountain species with altitudinal requirements coinciding with those of *Cliffortia paucistaminea.* In its distribution it seems limited to the mountains between Katberg and Stutterheim. I have found it growing nowhere else, not even in places where the climate and the vegetation suggest that the conditions for it would be ideal. Two outliers have been recorded by other collectors: Rattray No. 414 in the herbarium of the Albany Museum, from "East London", and MacOwan No. 1260 from "mountains near Grahamstown". Since the locality of Rattray's specimen is not precise, there is little hope of checking the validity of his record. MacOwan's record cannot be relied on, for there are two separate species under his number 1260—*Erica brownleeae* and *Erica calycina*, in the Bolus Herbarium and at Kew respectively. His number is quoted under both in the *Flora Capensis*, in Vol. 4, Part I, pages 251 and 294.

The highland macchia grows best on the south-facing mountain slopes (photographs 38, 52, and Figure 7), a dark green covering which from a distance looks easy to walk through, and lends to the most rugged country a deceptively soft and even appearance. Dense stands of *Cliffortia paucistaminea* grow into an interlacing mass which is for practical purposes impenetrable to people or to stock. Even when the plants are immature and only a few feet high, they cause acute discomfort to anyone walking through them because of the irritation set up by their mucronate leaflets which lodge in the clothes and afterwards work through to the skin. The discomfort is intensified with the height and density of the plants, and often added to by the several species of Rubus which thrive in these highlands. Below the canopy the accumulation of old dead growth forms a jagged lattice-work strong enough to make very rough going. Erica leaves are not mucronate and thus do not cause so much irritation as those of Cliffortia; other than this there is nothing to choose between these plants in the matter of obstructing the movement of stock or people.

Cliffortia is thicker on the slopes than on the flats or ridges and appears more sensitive to drought and heat than *Erica brownleeae.* There are often alternating communities of these two species in consequence, Erica occupying the exposed features and Cliffortia keeping more to the dips and rocky ground, but where there are no clear-cut differences in the habitat, Cliffortia and Erica may be intimately mingled. On the whole, the ground dominated by the highland macchia is shared more or less equally between the two.

Erica seedlings are tolerant of all but the deepest shade, such as is found in forest patches and in the densest thickets of their own community. Elsewhere in the highlands, between and including the extremes presented by thick grass and bare ground, they grow in the greatest plenty, nor is there any perceptible difference between their behaviour and that of Cliffortia seedlings. Mature bushes also are killed by deep shade, as is shown in the pine plantations of Chatha Forest Station. Some of the young pines, planted where there was macchia growing, have now grown above it, and none of the macchia remains alive. Measurements made by means of a General Electric exposure meter indicated that the ratio of the light intensity in the open to that in the pine plantation was approximately 300 to 1. As seedlings of indigenous forest trees are making good growth under the pines, one may infer that it is not lack of water that killed the macchia, which is a more xeric formation than forest (see page 74).

Subject to the provision against excessive disturbance, which is discussed under Ornithogalum (page 109), both species show a tendency to become established more easily in places where the grass cover has been removed or weakened. This is noticeable along old cattle paths, gullies, areas heavily trampled, firebreaks and the like, and is shown in photographs 39 and 40. Another example may be seen in the ministerial grazing on Chatha East. The centre of this camp is pure grassland, sandwiched between two areas of macchia. It is significant that the macchia adjoins the two entrances to the camp, and that the grassland is further away from them. There are probably four favourable influences in such places, firstly a brighter light, the effects of which have already been discussed, secondly a better supply of soil moisture, the effects of which are shown in photograph 41, thirdly less carbon dioxide in the soil air (page 29) and fourthly protection from annual grass fires (page 90). Once the macchia becomes established it rapidly shades out the plants which formerly possessed the area. Grass tufts turn unhealthy and die away to leave etiolated wisps, and a few non-grasses, commonly *Hydrocotyle asiatica, Hypochoeris radicata* and *Alepidea* sp., make up the remainder of the scanty undergrowth. There is no stock feed worth considering except the macchia itself, wherever it is dominant and mature (see Table 32).

PROPAGATION

Cliffortia has been seen in full flower as late in the season as March, but most of the flowering takes place in mid-summer. The unisexual flowers, scattered along the branches, are wind-pollinated. Ripe seeds may be found at any time during the winter. They are not easy to collect in quantity because they are shed soon after they have ripened, but enough were obtained for preliminary tests in the laboratory, which indicated that they have a germination of 40 per cent at 70°F, the germination time varying from three weeks to three months. In their natural habitat, seedlings of all stages may be found in abundance throughout the year wherever the light is adequate. This has been discussed in more detail above. The leaves of the seedlings and coppice shoots are broad and soft, and quite different in appearance and texture from those of the mature plants, which Weimarck (1934, p. 169) describes as *pinoid* (see photograph 43). The juvenile form supports Weimarck's view that "the pinoid type of leaf has originated simply by an intense reduction in the width of the lamina . . ." Erica plants from 18 inches upwards may be found in full flower from October to February. They are insect-pollinated and the seeds ripen during the winter, mostly in May and June. They are about half the size

Table 32

PER CENT BASAL COVER

CHATHA WEST MINISTERIAL GRAZING

Dense Macchia (one quadrat of one square metre)

Non-grasses		*Grasses*	
Berkheya setifera	1	Unidentifiable	8
Erica brownleeae	142		
Helichrysum sp.	6		
Oxalis sp.	1		
Pteridium aquilinum	2		
Unidentifiable	4		
	156		8

Total basal cover 1·64 per cent.

Adjoining Grassland (three quadrats of one square metre)

Non-grasses		*Grasses*	
Berkheya setifera	5	*Andropogon appendiculatus*	408
Cliffortia paucistaminea	184	*Aristida galpinii*	27
Erica brownleeae	23	*Elyonurus argenteus*	316
Helichrysum argyrophyllum	133	*Harpechloa falx*	626
Legume	2	*Panicum ecklonii*	50
Pteridium aquilinum	16	*Sporobolus centrifugus*	10
Sedge	82	*Themeda triandra*	1267
Unidentifiable	14	*Trachypogon capensis*	130
		Tristachya hispida	31
	459		2865

Total basal cover 3324/300—11·08 per cent.

of a pinhead and average twelve to a flower, varying from five to twenty-two. Laboratory tests indicate that with a temperature more or less constant at 70°F, the germination is about 23 per cent. The first seeds begin germinating after three weeks and germination may continue for 4 months or longer. Although it has a lower germination than *Cliffortia paucistaminea*, what it lacks in this respect is more than made up by the quantity of seed it produces. Both species of Cliffortia have unisexual flowers (Weimarck, 1934, pp. 53, 65) and each female flower bears only one seed (Weimarck, 1934, p. 34). There appears to be no great difference in the numbers of flowers borne by Erica and Cliffortia. On the assumption therefore that they produce an equal number (x), the number of seeds produced would be as follows:—

Erica 12x
Cliffortia x/2.

That is, Erica produces twenty-four times the amount of seed produced by Cliffortia.

EFFECTS OF GRAZING

Cliffortia paucistaminea is grazed by stock, but reluctantly. The remarks on the checking of *Cliffortia linearifolia* by rotational grazing apply here as well, but control will be a more difficult matter because *Cliffortia paucistaminea* appears considerably less palatable than *Cliffortia linearifolia.* Erica is rarely eaten by stock. Even in times of great scarcity, signs of browsing in this community are the exception, and are limited to what are apparently nothing more than tentative mouthfuls here and there. It is hence very unlikely that Erica could be kept in check by controlled grazing alone in the parts where it is now growing. Further remarks on grazing are given on pages 86 and 91.

As the macchia matures, the lowest branches become cut off to a certain extent from the light and tend to die back, forming a gradual accumulation of dead wood at the base of every bush. Leaves, dead twigs, flowers and seeds, as they are shed, gravitate downwards, some being trapped on the way by the lower branches and some falling through to the ground, where they become matted and caked into a dense layer sometimes several inches in thickness. The density of the macchia shields this trash from dispersal by wind and rain and animals, and decomposition is relatively slow. The result is that all but the youngest macchia grows on a deep foundation of inflammable material. An examination of the green branches of Cliffortia shows that they also bear inflammable material—an encrustation of dead tissue made up of the basal parts of the leaves, which persist after the disarticulation of the laminae. The matter is discussed by Weimarck (1934, p. 166). Its density and height, and its production of dry matter make the macchia easily the greatest fire hazard in the district. Fortunately it is kept wet for a large part of the year by the high rainfall, mists, and winter snow, which make the risk of fire less than it would be in the drier climate of the lowlands. Even on the mountains, however, dry spells do occur, and it is indeed only a matter of time before a fire breaks out and consumes any given area of macchia. As the growth is densest on the slopes, the draught which is always produced by the rising of the heated air is a strong force in augmenting a macchia fire (see page 116). An army of beaters is helpless against any that is well-established, and counter-burning is the only possible way of stopping it. The most furious fires are those that break out when high winds are blowing. They are an unforgettable sight, and almost impossible to control, for the strength of the wind may be such that firebrands are torn from the bushes and sent sailing across country to start fresh outbreaks ahead of the main fire. On 26th August 1936 one started during a high wind somewhere near the headwaters of the Wolf River, travelling eastwards along the mountains as far as the eastern corner of the Eseka Forest. Mr. Harry Hunter, at that time forester at Chatha, saw its whole progress and states that firebrands were blown from the plantations across the valley to Chulu Ridge, a distance of about a mile and a half, and that they set one of the stock kraals alight near the northernmost group of huts on the ridge. Charred sticks were picked up at St. Matthews, 5 miles away.

The regrowth from this macchia was considerable again in 1942, but not sufficiently so to be burnt as it stood, for when Sonntag's experimental plot was laid out in that year, the macchia had to be cut down and dried before it could be burnt. By 1948, however, its density and maturity were such that it was again in a dangerously inflammable state, and on 8th September 1948 another fire, supported by a strong wind, sprang up in the Chatha West ministerial grazing. Its course was very similar to the one which had preceded it. It jumped the firebreaks with equal success, and in a short while had laid waste nearly all the exotic plantations in the Chatha basin, and nearly all the country above them.

Except for islands of vegetation which somehow escape being burnt, the transformation of the countryside after such a burn could hardly be more complete (photograph 42). Most side branches are burnt away to leave only main stems standing, and macchia areas formerly impenetrable may be crossed reasonably easily. A deep ash lines each dip and covers the streams with a blackened greasy scum. Rocks and stones of all sizes show fresh spalling, and projecting bits of earth like worm castings and molehills are baked hard and red, but ground which is even does not appear to be much affected, and the fact that the grasses almost invariably shoot again shows that their roots remain unharmed. Further evidence that the soil is heated only superficially is provided by new molehills and worm castings which are soon thrown up again. In this connection the temperatures recorded by Cook (1939) for grass fires are of interest. She found that although the temperatures above ground were high (over 600°C) there was little rise in soil temperature even at a depth of 2 inches.

The mummified body of an occasional lizard or snake may be seen, but rarely. Probably most of these animals receive sufficient warning to escape into holes or under the shelter of rocks. Of insect life no sign remains. The macchia is killed almost completely and nearly all the regrowth is from seedlings. The time taken for them to appear is probably dependant on weather conditions. One month after the fire of 8th September 1948, seedlings of grasses and *Hypoxis*, *Berkheya*, *Helichrysum* and *Scabiosa* spp. could be identified, but none of the macchia were to be found. Two months after the fire there were many more seedlings of these and other species, but still none of macchia. They were seen for the first time on 29th December 1948, and from then onwards countless new ones came up. It was noticeable that they were scarce where the macchia had been dense, and abundant where it had been sparse. The reason is probably that the dense macchia gives a burn hot enough to destroy most of the seed, for apart from the flames which envelop the bushes themselves, there is a slower fire which, fed from the litter on the soil surface, continues burning long after the blaze is over, and as far as the seeds are concerned is likely to be the more effective destroyer. As there are few plants that live in the weak light under thick macchia (page 82), a fire will leave such areas practically bare, and they remain so until seeds come in from neighbouring areas. After the September burn quoted in this paragraph, there were tracts of several morgen with an exceedingly scanty cover, and that consisting mainly of *Pteridium aquilinum* and *Rubus* spp., both economically useless plants. Parts up to eight square yards in area were destitute of any form of vegetation.

Heat appears to have a depressing effect on the germination of Erica seeds, as was indicated by the following test:—Four hundred seeds were sown on dry soil in a flowerpot and lightly covered with sand, then dry grass was heaped over the surface to a depth of six inches and set alight. The soil was kept continually moist after the initial watering two days after the burn. On the twenty-sixth day after watering was begun the first seedlings germinated, thereafter germination to a total of twenty-seven seedlings continued slowly for four months. A control batch behaved in a similar way except that the total number of seedlings was forty-nine. It is probable therefore that the rapid regeneration of Erica after a fire is in spite of the fire and not because of it. It has not yet been possible to test the reaction of Cliffortia seed.

In Cliffortia, regeneration from suckers may take place if the fire is mild (photograph 43), but this is rare, and coppice shoots from the base of the stem are commoner. Bushes which are merely signed will sprout again from the above-ground parts. Erica seems more sensitive to burning, because regeneration by suckers or coppice shoots has so far not been noted. With fires of less intensity the damage to Erica is patchy. The lower branches, with their accumulation of dead growth, are more vulnerable, and the higher greener ones usually escape. Such lightly burnt bushes are consequently more spindly, and have in addition a characteristic mottled appearance from the mixture of dead and healthy branches in them.

SUCCESSION

EVIDENCE FROM PROTECTED AREAS

If areas of highland sourveld are protected from fire and grazing, the indications are that they change to macchia. The plot established by Schonland in September 1923 is an example. In his account of the experiment (Schonland, 1927, pp. 8–9) he states that this plot was under grass in 1926, which statement is proved by photograph 45, taken at this time. There had been a spectacular change from Helichrysum to grass under his treatment, and he makes it clear in his summary (page 9) that he regards the original condition of these parts as "pasture ground covered chiefly by Rooigras". In this he is probably mistaken, as will be shown (see page 111). I have it on the authority of Dyer, who worked with Schonland, that *Cliffortia paucistaminea* and *Erica brownleeae* were originally absent from the plot. This is confirmed by the list of plants given in the appendix to Schonland's paper, and by photographs 44, 45 and 53. *Cliffortia linearifolia* was recorded, but has no significance at this altitude, which is 4100 feet (see page 77). Schonland is in error in giving the altitude as approximately 3000 feet on page 5 of his report.

The fence around the plot remained in place until March 1947. Towards the end it fell into disrepair, but for most of this period the plot was protected from uncontrolled grazing and stock was allowed in under supervision only—conditions ideally suited to the maintenance of a vigorous grass cover (Weaver and Clements, 1929, p. 392; Bews, 1921, p. 69; Story, 1939, p. 337; Henkel, 1947). A setback to any macchia that may have become established there was the burning of the plot on 8th July 1930, and again on 26th August 1931. Reports on these fires are in file V 2/2 of the Botanical Survey, Grahamstown. With the first fire "the plot was *completely burnt off*. Although it was only intended to burn a portion, the wind changed during operations, and the fire was completely out of control within a few minutes owing to the dense growth". The second burn was also complete, and took place during a high wind. I was fortunate enough to see the plot in September 1947, while some traces of its former vegetation still remained, and was struck by the amount of macchia which had grown within its boundaries, in spite of the circumstances just mentioned (see photographs 46–7). A count established that there were 131 bushes to the acre, both Cliffortia and Erica being represented. The bushes were up to 6 feet in height. Outside the borders of the plot they averaged 25 to the acre. A diagram of the counts is given in Figure 7. This is a very heavily grazed area and the note on excessive disturbance, page 109, applies here.

The plot has thus yielded information in excess of anything which Schonland could foresee, and, in a district everywhere exposed to uncontrolled grazing, exceedingly difficult to obtain. In terms of a clause in the original agreement entered into between Schonland and its Native owners (Schonland, 1923), the experimental ground was restored to them when the experiment was discontinued. But for that unfortunate clause, the district would have been richer by a plot which would have continued yielding interesting and valuable results. It has shown that Helichrysum gives way to grass, and grass to macchia. Problems that remain unsolved are the time taken for the macchia to become dominant, its final density, whether it is stable or whether it is in turn replaced by some other form of vegetation, and the respective rates of increase of Cliffortia and Erica. The plot was of particular interest because it was laid out on the northern slopes, which are much less readily invaded by macchia than those facing south.

The aerial photographs of 1938 and the photographs taken by White in 1948 show a clear and striking boundary between the surrounding Helichrysum and the grass on the experimental ground. The destruction since the fence was removed has been sudden and complete. Under the onslaught of the hungry stock converging from all sides upon it, the cover has reverted to Helichrysum so extensively that except for a faint line on the south side, the boundaries of the plot are imperceptible in the aerial photographs of 1950, and almost so if an inspection is made on foot. The macchia has been chopped down, sometimes to be used for rough brushwood sledges and sometimes apparently in a mere spirit of idleness. When fenced, the plot meant so much to the student and so

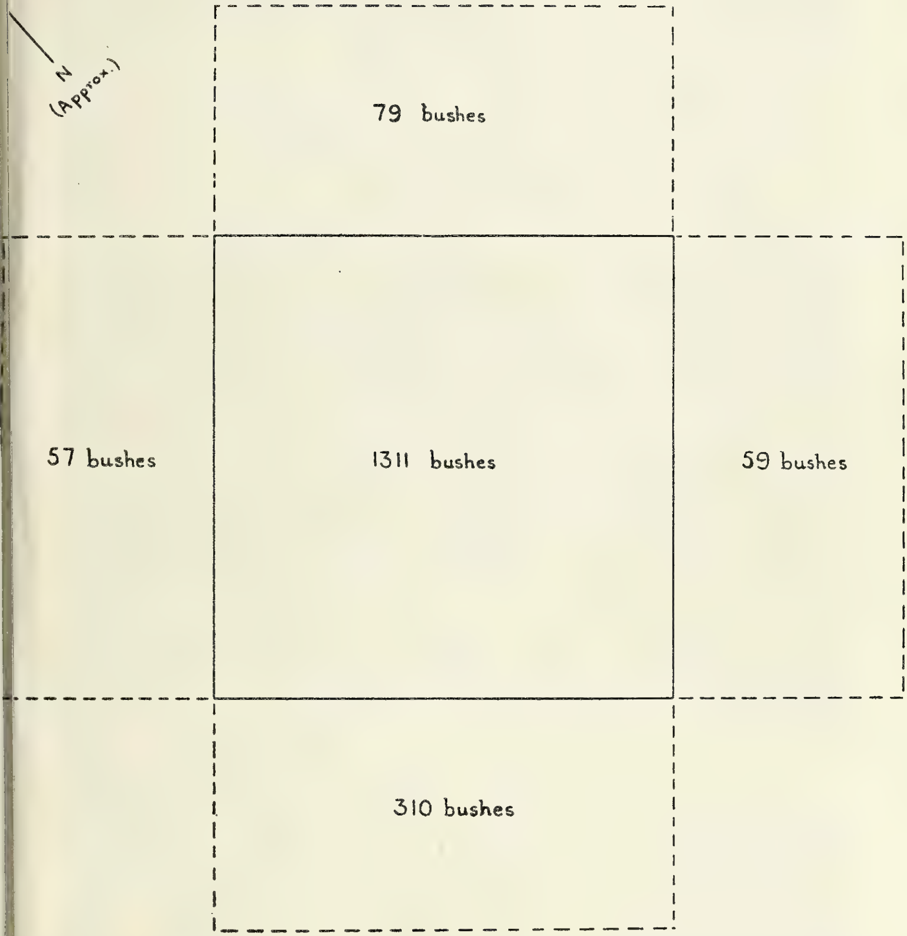


Fig. 7—Macchia in and around Schonland's Plot. (Inside plot: 10 acres, bushes 131 to the acre. Outside plot: 20 acres, bushes 25 to the acre. Note greater number of bushes on southern border of plot. This border is on the mesocline).

little to the Natives in terms of grazing that one can regard its ruin only as a matter of the greatest regret.

Mr. A. E. Sonntag and Mr. Harry Hunter have kindly given me information on the history of another experimental plot, in area half an acre, which was laid out at an altitude of 4700 feet in the south-facing macchia north of Chatha Forest Station. The enclosed macchia having been cut down and burnt where it lay, the plot was left undisturbed except for the cutting of six bags of grass in October 1947. The following is a summary of the report dated 8th January 1948 of Forester Harry Hunter:—

> "First year—fynbos and various grasses showed up slightly, but there was very little vegetation.
>
> Second year—grasses began to cover the whole area and fynbos was suppressed.
>
> Third year—the plot was well grassed, the fynbos scattered but coming through and 12–18 inches high.
>
> Fourth year—restored to very excellent grazing, scattered fynbos 2–3 feet high."

In the fourth year, the dense stands of Erica and Cliffortia, 5 to 7 feet high, gave the surroundings an appearance strikingly different from that of the plot itself, which had an excellent grass cover with only a little macchia apparent. However, a more careful examination established that macchia seedlings in it were numerous everywhere. Three belt transects of 90 square metres each were done in October 1947, and showed that the average number to the square metre was 14·4, that is, over 60,000 plants to the acre, and in number up to 52 to the square metre. They were growing without discrimination in the centres of tufts and between them, Erica predominating. Their vigour and the number well established left little room for doubt that they would in time cover the plot again and shade the grass out of existence. They were prevented from doing so by the fire of 8th September 1948 (described on page 84), which killed them root and branch and at the same time gave the grass an added advantage by stimulating it into luxuriant new growth. In spite of this setback, young seedlings, again coming up in their thousands, show that the macchia will inevitably oust even this abundant grass.

An interesting example of the development of macchia on a hilltop near Evelyn Valley Forest Station is recorded in the files of the Trigonometrical Survey, Kingwilliamstown. The record is by H. A. Ruddock, headed *Report on Tertiary Recce: Area* 32/37 *MP* 14 *King William's Town* and dated 4th August 1946. I am indebted to Mr. Ruddock for drawing my attention to this report and for allowing me to make the following extract:—

> "I found 91 WEST PEAK PIRIE completely smothered in extremely dense, rank, almost impenetrable vegetation, fifteen feet high and in places higher. I spent the whole day, with my Native assistant, clearing a few lanes to verify certain essential rays to the east. It was obvious that for rays to the south and west, at least one auxiliary station would have to be established, but as it was impossible to force one's way through the vegetation to the edge of the krantz, I had to leave this until later."

According to Mr. J. P. Roux, then forester at Evelyn Valley, the part round this beacon had not been grazed for many years. It was erected in 1912, at an altitude of 4184 feet. Copies of photographs of the beacon, taken in 1912, 1942 and 1947, were kindly given by the Director, Trigonometrical Survey. They are not clear enough for reproduction, but, as might safely be taken for granted, the earliest one gives an uninterrupted view of the horizon, and shows that the beacon in those days was prominent and exposed. The Director's minute states: "In 1912 there appears to be no vegetation in the vicinity of the beacon".

A fourth protected area exists by virtue of its inaccessibility. It is at an altitude of just under 6000 feet, and is situated half-way down the western cliffs of the mountain known locally as Chatha Peak, and shown on the Department of Irrigation map (1936) as Gxulu Mountain. To avoid confusion, the Native name Geju is used on the vegetation map which accompanies this paper. As a dark patch against the rock, this area is visible from many miles away. An examination through the field-glasses and by means of the aerial photographs showed that there was little likelihood that stock could reach it, and this was confirmed later when three separate attempts were made to visit this place on foot, all without success. At the fourth attempt, a way was found from the cliffs above, an easy climb but out of the question for stock.

The ledge is about 8 morgen in extent, sloping steeply to the west and bearing a thin, rocky soil. There is a little grass combined with a wealth of herbaceous plants round the edges of the macchia, but elsewhere it is seldom to be found, and apart from insignificant exceptions, macchia is dominant throughout. It is about 6 feet high, and is for the most part made up of Erica, Cliffortia being uncommon and confined more or less to the rockiest parts. *Protea lacticolor* is plentiful, and a few stunted specimens of *Kiggelaria africana* and *Buddleja salvifolia* are present. No other trees were seen. The ledge is not entirely cut off from animals. Roving troops of baboons forage through it and there is a permanent and large population of dassies and rodents to browse the vegetation. Sparse, and overgrown with a number of species of Helichrysum, a shorter growth of macchia over about half a morgen near the southern end shows unmistakable signs of having been burnt. Other than this, there are no traces of burning, and the bare encircling cliffs make it extremely unlikely that fire is anything more than a rarity brought in by a chance firebrand (see page 84).

If grass were the climax in the highlands above the forests, it would be difficult to find an explanation for the macchia on this protected terrace. The view that the grass may have been destroyed by dassies is not tenable, otherwise it would be destroyed also in the places where it is now growing. Moreover, dassies could be expected to suppress the macchia at least as much as the grass, for their food consists chiefly of the young shoots of shrubs (Sclater, 1900, p. 313). The run-off from the cliffs above must supply the terrace with water additional to that obtained from the rain which falls directly upon it. This probably favours macchia, but observations from the other protected parts, Schonland's plot especially, show that it would not be a decisive influence.

The evidence so far presented suggests strongly that the climax vegetation above the present timber-line and as far as the crests of the mountains is macchia. Certain anomalies remain to be discussed.

Historical Evidence

Mr. W. M. Spring has lived at Keiskammahoek for over 80 years. He states that when he was a boy he used to traverse the Amatole highlands on foot, sometimes sleeping out and not returning to the village for days at a time. Plainly Mr. Spring is unlikely to be wrong in his statement that the highland veld in those days consisted entirely of open grassland, and that macchia was absent. Confirmation may be had from any of the older generation, members of the public and officials of the Forestry Department alike, who knew the Amatole Mountains during the last century or in the early days of this. Mr. A. Köpke, at one time forester at Chatha Forest Station, can recall the Native cattle posts on the macchia slopes near the top of the present right-of-way west of the forester's house, in country exactly as described by Mr. Spring. Mr. E. B. Dwyer, formerly District Forest Officer, is quoted by Schonland (1927, p. 6) as follows:—

"I was stationed at Keiskama Hoek from 1889 to 1893, and the

> areas now affected" (by Helichrysum) "were then stretches of waving roo grass in autumn, and the paths up from Mnyameni to the ground behind were scarcely visible from below."

In an address read at the Queen's Jubilee Exhibition, Grahamstown, in 1887, Mr. D. E. Hutchins, then Conservator at Kingwilliamstown, states:—

> "Above the natural forests on the Amatola and Pirie ranges are extensive tracts of waste mountain land, yielding at present nothing but a coarse grass which burns annually in fierce fires and is every winter a source of anxiety to those in charge of the forest below."

Discussion

History shows indisputably that the Amatole mountain veld was formerly under grass, yet the botanical evidence is that the climax community is macchia. These two apparently contradictory views may be reconciled by a consideration of one important point mentioned by Hutchins, and itself a matter of history: *annual fierce fires.* They are the surest force in checking the spread of macchia and their influence in establishing a grassland sub-climax has been demonstrated locally in the plot laid out by Sonntag and Hunter, and is shown in photographs 48, 49 and 51. Similar cases with various other types of scrub and grassland are reported by Bews (1929, pp. 294, 296); Rowland and Hector (1932, p. 324); J. Phillips (1935a, p. 238; 1935b, p. 58) and Michelmore (1939, p. 305). In a specific reference to macchia, J. Phillips (1930, p. 335) states that fire "reduces the seldom abundant grass". His observations and those of the authors cited by him, however, refer only to the western Cape, where the climate, according to Schimper's classification (Schimper, 1903, pp. 173–4), is unsuited to grasslands and where circumstances may accordingly be different.

A reconstruction of the possible chain of events which has determined the composition of the Amatole vegetation of the present day is as follows:— The mountain slopes above the forests were originally under macchia as tall and dense as any to be found today. At some time in South Africa's prehistory, man started firing the slopes. Little by little, as the macchia became sparser and as its stocks of seed were depleted, the fire-resistant grasslands obtained a footing, and spread, until the macchia was confined to the sheltered ground among rocks and along ravines where the fires could not easily penetrate. With moderate grazing and frequent fires these grasslands remained stable, and it was at this point that the mountains were first known to Europeans and the nature of the vegetation recorded. Proportionately to the establishment of settled conditions, the population increased, and with it the numbers of stock. The grasslands were cropped short and fires became weaker and less fequent. Macchia began migrating out from its strongholds, the patches linked, and within a relatively short period after the founding of Keiskammahoek, in the neighbourhood of 60 years, it had re-established itself over much of its former home. It is rare indeed for the succession to be hastened by disturbances caused by man or his stock, so much so that Bews (1931, p. 7) has given it as his opinion that "man's interference always tends to send back the plant succession". But this is not an invariable rule, as the behaviour of the macchia shows, and as do other examples given by Phillips (1935a, p. 239) and Weaver and Clements (1929, p. 408).

The time taken for grassland or Helichrysum areas to change to macchia, although dependant mainly on the supplies of macchia seed present, varies also according to competition from the grasses and according to the aspect, as shown in photographs 38–9. It is understandable then that it is not possible to forecast times with any accuracy, and the few examples to be quoted do no more than give a very incomplete picture of the speed of succession with uncontrolled grazing. Photographs 50–1 show that even where there are alternes of Helichrysum, grass and macchia, little change may be expected in their relative proportions within six years. This has been confirmed by other dated photographstaken in the Chatha West ministerial grazing. They are not suitable for reproduction.

A comparison after a period of 12 years is provided by the two sets of aerial photographs, taken respectively in 1938 and 1950. They show that this interval is enough to allow appreciable amounts of macchia to invade parts previously bare, or spread in parts where it was previously thin, and to form a community dominating between 20 and 50 per cent of the area. From these examples one may conclude that the increase of macchia under present conditions of grazing is generally inconsiderable in under six years but considerable after twelve.

Twelve years may be long enough to allow a marked spreading of the macchia even in protected areas. This has occurred on the plateau overlooking the Maden Dam from the north-west, in the protected catchment area at Evelyn Valley Forest Station, and may be seen at a glance from the two sets of aerial photographs. That the process is relatively slow, however, is shown by the fact that the spread is even more marked in the area adjacent and to the west, which is subjected to uncontrolled grazing by Native stock.

Examples from a third area will show how conditions may vary within a radius of a few hundred yards. Schonland's plot, clear of macchia in 1931, on a northern aspect and with sources of seed two or three hundred yards away, had after 18 years accumulated 131 bushes to the acre, or one to 38 square yards—a striking concentration by comparison with the immediate surroundings (see page 86 and Figure 7). The immediate surroundings are Native commonage and are subjected to very heavy grazing by all kinds of stock, including goats, which are not permitted in the ministerial grazing. In addition, the aspect is a hot one. Judging by the present bareness of the area, these two influences are a combination which may be expected to keep the land clear of macchia indefinitely. Slightly to the south the aspect is favourable, and here the macchia can successfully overcome the one remaining influence of heavy grazing. Photographs 52–3 show clearly how it has done this since 1926.

This small area shows then that heavy grazing and a hot aspect inhibit the growth of macchia almost entirely, controlled grazing and a hot aspect allow a slow increase of macchia, and heavy grazing and a cool aspect allow a rapid increase.

It is at present vain to speculate on the age when the macchia was originally dominant on the Amatole Mountains. Certainly man was present in the district long before the Bantu arrived, for middle stone age implements now stored at the Albany Museum have been collected on Mount McDonald, and Bushman implements near Middledrift, by Hewitt and Stapleton, but whether early man regularly employed fire in his hunting activities on the mountains is unknown. He could easily have done so. When conditions are favourable, no more than a spark is necessary to clear away areas of macchia which an army could not otherwise destroy. Prof. M. Wilson, of the Department of Social Anthropology at Rhodes University, considers that prehistoric hunting fires were very probable, and, in support of her view, states that fires started by the present-day Bushmen are a cause of friction between them and their cattle-owning Bantu neighbours.

It is doubtful whether fires arising from natural causes before man reached these parts would have occurred sufficiently often to keep the vegetation at the grassland stage. Natural fires are mentioned by J. Phillips (1930, p. 352), who does not comment on their possible frequency, and by Clements (1916, p. 57). Referring to Idaho and Montana, regions of frequent dry thunderstorms, he states "the number of such cases would appear to be large". He does not, however, give any figures to support his statement. One took place recently in the Tarka district when the southern of the two flat-topped hills Mary and

Martha was struck by lightning. This started a fire which swept the whole plateau, and is the only authenticated case known to me, apart from the firing of a single tree during a storm in the Hogsback forests which has been reported by Prof. M. Wilson. From the lack of other specific instances, such fires, in the Cape at least, appear rare, and because regeneration of macchia from seed is good, it is not rare fires that prevent its establishment, but frequent fires.

Grass is never totally absent from the climax macchia (page 103, paragraph 1), and as well as scattered individual grasses there are the larger communities discussed in Chapter 4. It does not have to migrate in from another formation and it is thus not difficult to account for its presence once the macchia has been destroyed.

POST-CLIMAX STAGES

In the opinion of some workers, the macchia in the sourveld is merely a stage towards a forest climax, probably not high forest as found below the present timber-line, but something taller and more robust than the macchia. The following observations support this postulation:—

1. *Buddleja salvifolia* was recorded from Schonland's plot between 1923 and 1926, and specimens were still present in 1949. They were found scattered through the Helichrysum outside the plot as well. A single specimen of *Halleria lucida*, not recorded by Schonland, was growing in the plot in 1949.

2. Occasionally, high exposed parts support trees in some quantity, as may be seen 16 miles from Keiskammahoek on the road to Stutterheim. Rare stunted specimens of *Podocarpus latifolius* are found along the peaks of the Amatole range, and isolated trees of other species occur sporadically in the bleakest sites. The following is a list of those so far found:—

Bowkeria sp.
Buddleja auriculata
Buddleja salvifolia
Canthium ciliatum
Cassine kraussiana
Cassine tetragona
Cussonia paniculata
Euclea undulata
Gymnosporia acuminata
Gymnosporia buxifolia
Halleria lucida
Heteromorpha sp.
Kiggelaria africana
Myrica sp.
Osyris compressa
Podocarpus latifolius
Rapanea melanophloeos
Rhamnus prinoides
Rhus dentata
Rhus pyroides.

At 4000 feet, thickets of some of these species have developed in the forest reserve in the Kaga Mountains north of Bedford. Although they occur in places not so well sheltered as those under forest, they are absent from those most exposed. The trees forming the thickets at Bedford are:—

Buddleja auriculata
Buddleja salvifolia
Cassinopsis ilicifolia
Grewia occidentalis
Gymnosporia buxifolia
Heteromorpha sp.
Leucosidea sericea
Pittosporum viridiflorum
Rhamnus prinoides
Rhus spp.

There are dense patches of bush overgrown with *Clematis* sp. and alternating with glades in which *Cymbopogon marginatus* is dominant. *Cluytia affinis*, *Cluytia pulchella* and the scrambling *Helichrysum petiolatum* are among the commonest plants in the matted growth of herbs and undershrubs. A similar community grows at an altitude of about 4500 feet on a terrace on the western slopes of the range north of Seymour, about a mile north-west of point 5106. (Reference map S.A. 1: 500,000

Sheet Queenstown SE 33/26). It occupies the same type of position, intermediate between the exposed high ground and the sheltered forest belt. At Evelyn Valley is another example, growing in the folds of the catchment area above the indigenous forests. The altitude is about 3500 feet.

3. Slopes of talus above the Amatole forests are often under flourishing communities of trees, sometimes a mile or more from their nearest neighbours. The Chatha area has several of these isolated tree patches, and others occur on the farm Coolin, on the south slopes of the Elandsberg, up to about 6000 feet. Those on Coolin, being the largest and the furthest from the forests, are of particular interest. The scree is made up of a confusion of angular rocks, between a few cubic feet and several cubic yards in volume. With the possble exception of goats, stock cannot walk across them, and when fencing, farmers here and elsewhere sometimes are able to turn this to advantage by using them as natural barriers, linking them with lengths of fencing and thus saving considerable amounts of material. Some patches of trees grow in the middle of the scree, but most by far keep faithfully to its edges and form a hedge all around it from two to fifteen yards in thickness (see photograph 54). The trees comprising it are:—

Bowkeria sp.
Buddleja auriculata
Buddleja salvifolia
Euclea undulata
Gymnosporia acuminata
Halleria lucida
Heteromorpha sp.
Kiggelaria africana
Rhamnus prinoides
Rhus pyroides.

4. Various species of pines, gums and wattles, self-sown, grow freely in the highlands up to and over 5000 feet above sea level (photograph 37), and small plantations of poplars in the Kaga Mountains north of Bedford likewise, at 5000 feet.

The examples mentioned all indicate that trees can grow in the highlands, and therefore that macchia may be a seral community, but they require a certain amount of qualification.

The forest on the road between Keiskammahoek and Stutterheim is at an altitude of only a little over 3000 feet, and thus below the zone in question, in a region of milder temperatures. The Buddleja and Halleria in Schonland's plot, the other indigenous trees scattered over the highlands, and the thickets on the Katberg, on the Kaga Mountains and at Evelyn Valley cannot be so easily dismissed. Singly these examples might with a certain amount of justification be regarded as exceptions, together they make it plain that a type of vegetation sucessionally more advanced than the macchia may be able to grow above the forests. A significant point is that the thickets are always in shelter. The individuals in exposed or high places do not give any indication that they are on the increase, as may be seen from those in Schonland's plot, and in the protected area on Geju Mountain, nor do the indigenous trees which clothe the lower slopes of the Hogsback at King's Nek show any sign of extending further towards the summit. They are found in a belt along the lower slopes only. Had they once covered the whole mountain side, there would be no apparent reason for their present absence from the upper parts of it, for the slope is even and the soil uniform.

Poplars and many other exotic trees can largely avoid the rigours of the winter by casting their leaves (Hutchins, 1887). This reduces their water-loss and enables them to withstand the physiological drought which can at times prevail in the highlands, and which is discussed in Chapter 4. This adaptation to drought has been noted also by Rawitscher (1948, pp. 255–8), who reports that the deeper-rooted plants in the drier areas of Brazil reach the water-table and are evergreen, the shallow-rooted ones being deciduous in the dry season. Nearly all of our indigenous forest trees are evergreen and hence do not possess this means of enduring drought. Hutchins states that we have only three which are deciduous, those he has in mind being probably *Celtis kraussiana*, *Calodendrum capense* and *Rhus legati*.

The tolerance of wattles is apparent from a paper by Wood (1934, pp. 71, 85) in which he mentions the frequency of the phyllode-bearing Acacia species in the 8-inch rainfall zone of Australia, and states that this type of leaf is "characteristic of all climates except that permitting rain-forest development".

Gums as classified as xerophytes by Maximov (1929, p. 284).

Reference to the xerophytic or tolerant nature of particular species of Pinus (*Pinus sylvestris*, *Pinus ponderosa* and *Pinus montana*) are given by Braun-Blanquet (1932, pp. 142, 267) and Warming and Vahl (1909, pp. 216, 312, 314). That this nature is characteristic of the conifers as a whole is shown by Wells, Huxley and Wells on page 658 of an undated publication in the following statement:—

> "Conifers reappear again polewards of the main temperate zone. The encircle the whole of the northern hemisphere. An almost unbroken belt of them, four hundred to eight hundred miles wide, stretches for over five thousand miles from Scandinavia to the Pacific. In Siberia it is called taiga; but elsewhere, strangely enough, it has earned no special name. And a second huge forest of the same type covers the North American continent from Labrador to Alaska. Sometimes such a forest is all of fir, dense and gloomy; but deciduous trees like birch and alder may break the inhospitable monotony. Firs, however, are the dominants. Yet this does not mean that they find themselves here in the most favourable conditions, for spruce from sub-artic North America grows much larger and better when transplanted to the milder climate of Scotland. It only means that, in the struggle for existence, they can survive where other trees with greater demands fail. They are not in any perfect adjustment with their not very attrative environment, but they are better adjusted than any other trees."

In a paper by Cannon (1914, p. 230) the same view is expressed:—

> "The fitness of the conifers in general to life in high altitudes, where the evaporation rate is great and the absorption of water is retarded by a low temperature . . . is well known."

The tolerant nature of gums and pines may be deduced also from the fact that many of those in plantations above the forests are planted for windbreaks or as ornamental trees on karroo farms, where most of the indigenous forest trees would have no hope of survival. It is thus evident that the exotics that have been mentioned are better adapted than our indigenous trees to withstanding the physiological winter drought of the highlands, and accordingly their presence does not necessarily give grounds for assuming that the environment is suitable for our native forest trees as well.

Let us suppose that the trees which border the talus slopes are vestiges of a former extensive vegetation which has been destroyed by man. Man could have destroyed the trees only by felling or burning. Felling may be ruled out, for no rational people would have gone to such enormous pains for no obvious purpose, nor would they have eradicated practically every tree and yet left a fringe, perfectly easy of access, round each talus slope. Burning is also out of the question. The bare scree would certainly have given protection from fire to any trees growing away from its edges. The existing ones, however, border it, and would have been in direct contact with the hypothetical ones which were burnt. It follows that the fires which killed the hypothetical ones would have killed the existing ones also. There is a possibility that fires originally made a clean sweep of this whole area, talus slopes included, and that the present trees are a new generation, established on the only places where fire cannot reach them, and prevented from invading the encircling grasslands because the grasslands in this area are burnt as a matter of routine. Direct evidence to the contrary is lacking, but indirect evidence suggests that this theory is unlikely to be correct. Firstly, a similar relation between scree vegetation and that surrounding it holds good in South Africa even where veld fires are rare or unknown. Examples may be seen two miles east of the road between Cradock and Zwagershoek from a point eleven miles from the railway crossing outside Cradock. Others occur in the Graaff-Reinet district on the slopes of the Tandjesberg. They are visible from the road near Petersburg, about twenty-four miles east of Adendorp in a direct line, and from the main road between Pearston and Graaff-Reinet. Secondly, screes in other parts of the world have been shown to support not a climax community but a post-climax one. Weaver and Clements (1929, p. 477) report ". . . other post-climaxes occur on escarpments, talus slopes and rocky hills from western Texas to Mexico and eastern California." Thirdly, scree on the Alps, where grass-burning is not practised, supports dwarfs shrubs, while "in less steep places, grassland predominates, and higher up, as far as perpetual snow" (Schimper, 1903, p. 775).

The evidence taken as a whole suggests that the macchia may in sheltered places and at the lower altitudes be replaced by the type of low scrub which is under discussion, but that it is nearly everywhere else the climax on the Keiskammahoek highlands.

OTHER COMMUNITIES

Although the extent of the Cliffortia and Erica communities makes them easily the most important constituents of the macchia, there are several other plants common enough to be mentioned specially. They are *Protea lacticolor*, *Bobartia gracilis*, *Rubus* spp., *Pteridium aquilinum*, *Stoebe* spp., *Passerina* spp., *Metalasia muricata* and the communities on the vleis.

RUBUS SPP.

There is a persistent belief that the *Rubus* spp. are all introduced weeds. Rattray's specimen of *Rubus pinnatus* No. 320 for example, collected on the Hogsback in 1920, bears the note "cultivated, but now found in many parts of this altitude". It was, however, collected by Ecklon and Zeyher on the Kat River more than a hundred years ago, and is listed among the indigenous species in the *Flora Capensis*. *Rubus rigidus* is another indigenous one from the district. *Rubus affinis* and *Rubus immixtus*, two more common local species, are not listed in the *Flora Capensis* and are therefore presumably introduced.

All are apt to become prominent in parts subjected to heavy trampling, particularly in conjunction with burning. Their increase with the rate of stocking is evident in the ministerial grazing of Chatha East, directly above the forester's house. The ridges of the buttress slopes descend in a series of slight curves, each of which ends in a more or less horizontal platform at its lower end. Because of the steepness of the slopes, the cattle when they wish to rest come together on these small headlands, which are consequently more severely trampled than the slopes. There is nearly always a growth of Rubus on them, but in the surroundings it is as yet very rarely seen. *Erica brownleeae* is also beginning to invade the headlands, which is in accordance with the observations recorded on page 82.

By burning, Rubus is stimulated into putting out a greatly increased growth of long stout runners radiating from the crown of the main plant, and growing downwards at the tip into a small hook which may take root and become another source of runners. The repetition of burning results at last in an infestation like that shown in Table 33. The figures are from a line transect put across a firebreak east of King's Nek above the indigenous Schwarzwald Forest, Wolf Ridge Forest Reserve. The firebreak is made by clearing two parallel strips through the vegetation and burning what remains between them. So far, the Rubus in the burnt area has increased to nearly five times the amount outside it. These observations agree with those of Sim (1907, p. 216), who notes that "they are among the first ligneous plants to resume occupation after a fire has cleared a forest area . . ." Stent (1925) quotes an Australian paper which advises burning as a method of control, but this is admittedly in conjunction with digging out or ploughing—both impossible to carry out economically over the rugged country which is overgrown with Rubus at the present time. No satisfactory method of eradication has yet been found.

Table 33

EFFECT OF BURNING ON GROWTH OF RUBUS LINE TRANSECT FIGURES

Unburnt area	Periodically burnt area	Unburnt area
38 paces	76 paces	38 paces
7 stems	85 stems	11 stems

Total stems on transect line, burnt area 85
unburnt area .. 18

An interesting fact is that in the catchment area at Evelyn Valley where the same system of burning the firebreaks is carried out, the burnt areas are under grass, with only a little Rubus (photograph 55). The essential difference seems to be that the Evelyn Valley area is protected from grazing. The other area is Native commonage, and grazing, which is at all times heavy and uncontrolled, becomes specially severe where burnt areas provide an early greenness. The Rubus here is not only stimulated, but is provided as well with a clear field to invade, free from grass competition.

PROTEA spp.

Protea lacticolor dominates a mixed community common in the wetter parts of the ministerial grazing. With the exception of the plateaus, it covers a great deal of the country at the source of the Wolf River. Smaller patches line the upper reaches of the mountain streams and cover the flushes throughout the ministerial grazing. Although the Protea is often widely scattered, it seems by its presence alone, and not by its frequency, to be a reliable indicator of a moist vegetation. Other characteristic plants are:—

Agapanthus sp.
Anthospermum aethiopicum
Anthospermum lanceolatum
Athanasia punctata
Berkheya decurrens
Cliffortia serpyllifolia
Cluytia spp.
Cuscuta sp.
Cyperaceae
Diascia rigescens
Euphorbia epicyparissias
Gunnera perpensa
Hebenstreitia dentata
Hydrocotyle asiatica
Hypochoeris radicata
Kniphofia spp.
Leonotis sp.
Plectranthus calycinus
Psoralea pinnata
Restionaceae
Rubus spp.
Stoebe cinerea
Trifolium sp.
Zantedeschia aethiopica.

The Cuscuta may in many parts smother the plants under a heavy curtain of runners in vivid yellow patches several yards across. Away from this community it is rare. *Euphorbia epicyparissias* is usually scattered, but may dominate small areas of a morgen or so. The many other species occurring together with the plants listed are sometimes rare and sometimes common according to the locality, and it is doubtful if this patchiness is anything else than fortuitous.

The mixture may be open, as at Chatha, but often forms an interlaced mass, thorny with Rubus and up to 6 feet high, of which examples may be seen along parts of the Wolf River. It is then for practical purposes impenetrable, and gives outstanding protection where protection is most needed. Its value as fodder varies according to the vegetation of the community itself as to density and species.

Fire destroys the Protea plants but many of the seeds escape. There is evidence of this on the upper slopes of Geju Mountain, where among dead and blackened stems of the older plants a crop of 12-inch seedlings is coming up. After the fire of September 1948 (page 84), the seed escaped from the charred capitula and massed into drifts beneath the trees, sometimes a foot deep in hollows on the ground. It appeared unharmed, but no germination tests were carried out.

The flowers, ranging in colour from white to red, are out in midsummer. Although not as showy as most other members of the genus, the tree is nevertheless an ornamental one. It is otherwise unimportant.

Protea multibracteata is found scattered through the open sourveld and in drier localities than those favoured by *Protea lacticolor*. A note on Dyer's specimen No. 370 in the herbarium of the Albany Museum states that it is a tree 10 to 15 feet high. The specimen is from the Katberg. This Protea forms an open parkland on the high level country above the Dontsa Pass on the road between Keiskammahoek and Stutterheim. What appears to be a different variety grows on the Chatha East ministerial grazing. It has, just below the surface of the soil, a thick and gnarled part which sends up a few slender 3-foot flowering stems, and the species has been recorded by Henkel also as a "grassland shrub". The two forms may be found together in this locality. The thick underground parts of the shrub make it unlikely that it is merely an immature form of the tree. Whether the differences in habit are inherent, or whether they are caused by the presence or absence of grass fires is not known.

The flowers resemble in size and colour those of *Protea lacticolor*, and are out at the same time. Mr. P. L. P. Clerk, who is a beekeeper at Kubusi Forest Station, states that they are a valuable source of nectar.

METALASIA MURICATA

This plant occurs also in the *Cliffortia linearifolia* community, but only near its upper limits. At these altitudes it grows into a tree up to 12 feet or more in height, with white inflorescences, and these tall specimens are found along the south-eastern border of the district, reaching their greatest size in the Evelyn Valley macchia. Elsewhere it is a rare species. There are a few here and there on the steep slopes below the cliffs of Geju Mountain, but these plants are dwarf shrubby forms not more than a foot in height. The inflorescences are pink instead of white. This colour variation is mentioned in the *Flora Capensis*, but without any remarks as to the habitat of the coloured specimens. It is possible that the colour is correlated with high altitudes, as has been recorded for various other flowers by Bews (1917b, p. 520).

The bushes are not readily eaten by stock and are too uncommon to be of importance. Like the Cliffortia and Erica they accompany, they are killed by fire.

BOBARTIA GRACILIS

There are about a hundred morgen under this community at Keiskammahoek. It is generally absent where the highland macchia occurs, and grows best in company with the *Cliffortia linearifolia* community. The scattered patches are usually dense, and end abruptly in a regular outline, intervening strips of country being often quite free of Bobartia. It occurs mainly on the plateau west of West Peak Pirie and in this neighbourhood, with smaller patches on Mount Kemp and on the terraces between Mount Kemp and Gwili-gwili.

Unless driven by starvation, no stock will attempt to eat it, for leaves and flowering stems are alike hard and wiry. It is exceptionally hardy, suffering no more than transient damage from burning, and thriving where there is heavy and uncontrolled stocking. The leaves and stems of each plant arise in a dense tuft and are too closely set to offer refuge to other less hardy species except on a very small scale. It may be used for thatching but does not appear to be put to this use locally, for suitable grasses are more plentiful and easier to obtain. In other parts of the country, durable basket-work and matting are made from it. At Keiskammahoek, therefore, although it has potential uses, it is at present nothing better than a nuisance.

PTERIDIUM AQUILINUM

This is the commonest fern of the macchia and forest margins. It has a thick subterranean rhizome which according to Sim (1915, p. 264) may be several yards long. The rhizome remains unharmed by fire and the new fronds are among the earliest signs of green after a macchia burn. In company with *Rubus* spp. it often dominates miles of forest firebreaks, for the regular manual clearing which is done on them is too superficial to damage the rhizomes. It has no economic value in the district. Theoretically it is poisonous to stock, for practical purposes it constitutes no danger to them (Collins and Wild, 1950, p. 17).

STOEBE SPP.

Stoebe cinerea and *Stoebe plumosa* are the two species which have been collected locally. *Stoebe cinerea*, the commoner of the two, is distributed patchily over most of the highlands, with concentrations in the vicinity of Mount Kemp and in parts of the Hogsback near King's Nek, and according to a note on Rattray's specimen No. 100 it covered large areas on the ridge between Amatole Basin and the Tyhume River in 1918. In the Bedford district it is becoming a serious pest on some of the farms in the Kaga Mountains. According to the *Flora Capensis*, it occurs "in dry ground and by roadsides, throughout the Colony", but locally at any rate it demands a good supply of soil moisture, communities of it being interrupted on dry slopes or where the soil is scanty by patches of Clffortia and Erica. Levyns (1937, p. 5) reports that it is "a plant of low and moderate altitudes" in the western Cape, but it grows well in the Amatole Mountains in places over 5000 feet above sea level.

By scrambling over the tops of other small shrubs it often smothers them so effectively that areas of a morgen and over may be entirely covered by it, in a closely-matted, yielding stand up to 5 feet high. Although it is useless to man or beast, it is nevertheless of value in binding the soil and protecting it from trampling by stock. It is very seldom eaten, and then only when young.

The closely-allied species *Stoebe vulgaris* has been studied in detail by Cohen (1935, 1940), and his findings would possibly give an indication of the behaviour of *Stoebe cinerea* also. They may be summarized as follows:—

1. There is no vegetative propagation.
2. Seeding and germination are good.
3. It is resistant to fire, but there are indications that frequently-repeated burning might kill it.
4. Seeds ripen in winter and are destroyed by fire.
5. It can establish itself best on open ground.
6. It is encouraged by heavy stocking, counts showing that there is twice as much Stoebe on grazed areas as on ungrazed areas.

Stoebe plumosa grows more sparsely, and is a smaller bush than *Stoebe* *cinerea*. It has not been noticed in any extensive communities and is not at the moment a problem of any importance.

PASSERINA SPP.

The species recorded from Keiskammahoek are *Passerina montana*, *Passerina vulgaris*, *Passerina filiformis* and a species not yet named with certainty.

The unnamed species has been collected from the watershed between the Wolf and the Mnyameni Rivers and from the Katberg (Story Nos. 3778 and 3876, in the National Herbarium, Pretoria), but as a rarity only. It is at present of no economic importance.

Passerina montana is known from the eastern Cape to Southern Rhodesia, and from 3000 to 10,000 feet above sea level (Thoday, 1924, p. 153). On the northern of the two hills Mary and Martha, which are about 12 miles south-east of Tarkastad, it is dominant over most of the plateau, with relatively insignificant amounts of *Aster filifolius* and *Helichrysum trilineatum*, and a few dwarfed specimens of *Royena hirsuta* and *Euclea undulata*. As the hill in question is never grazed and is almost inaccessible even to people, one may conclude that something similar to this vegetation is likely to be the climax on the mountain tops in the neighbourhood. Yet on the southern of these two hills Passerina is almost absent, and grass is dominant over the whole plateau, in spite of the fact that conditions there are almost identical with those on the northern hill. It is nearly as difficult to climb, and only once have sheep been known to reach the top (Pio, 1948). Numbers of charred sticks, however, show that shrubs were once present in larger quantities, and the fact that the plateau was burnt in February 1946 provides an explanation for their present scarcity, and suggests that *Passerina montana* is in these parts the equivalent in function and behaviour of the Cliffortia and Erica of the Amatole Mountains.

Away from the mountain tops *Passerina montana* is absent probably because the Tarka climate is too dry for it except at high altitudes. The average rainfall for the district according to the rainfall map (Department of Irrigation, 1939) is less than 20 inches. Near the Winterberg, where the rainfall is between 20 and 35 inches, its range is not so limited, and it has within living memory encroached widely on parts that were formerly free of it (Liebenberg ms.). The reasons may possibly be the same as those put forward on page 82 for the recent increase in the Amatole macchia—less competition from the grasses and fewer fires.

As a means of control, Liebenberg suggests burning, or using goats to browse it, and gives an instance where goats have been used to good effect.

It was collected on the Hogsback by Rattray in 1920, but as it is 30 years later still not a common plant, the indications are that it cannot here compete with the more robust Cliffortia and Erica. If ever it does show signs of increasing at their expense, the possible cause may be looked for in a climatic change towards drier conditions.

Passerina filiformis dominates the western half of the small plateau which lies immediately north of the Mount McDonald beacon. The bushes are about 2 feet high, and in habit so much like *Cliffortia linearifolia* that at a distance they could easily be mistaken for it, except that their colour is a darker green. They show no signs of being browsed by stock, although the plateau is heavily grazed by cattle, and by donkeys in smaller numbers. The community is densest on the edge of the plateau overlooking the Amatole Basin, thins out towards the centre of the plateau and is absent on its eastern side.

No other communities of this bush have been found in the district, and why it should be confined to this particular area is unknown, but it appears robust and is reproducing itself well, and there is no apparent reason why it should not spread. As it would be most undesirable if this should happen (for it seems to be a useless species), eradication by hand is advisable as soon as possible, while the task is still an easy one. Killick (1950) who reports on its dominance on parts of Table Mountain, near Pietermaritzburg, states that it is destroyed by fire, but in the local patch the vegetation is kept too closely grazed to admit of burning, nor is the Passerina yet dense enough to burn without additional fuel.

Passerina vulgaris is widespread throughout the Cape Province and common in the Albany and Bathurst districts, where it dominates small areas along the coast and on stony hills inland. At Keiskammahoek it may grow anywhere in the macchia, but is nowhere common, and as a community it has so far been found only in a strip along the southern edge of the plateau on the southern border of the district, near the beacons Zanyokwe 97 and Zanyokwe Auxiliary 308 (see photograph 56). The strip is at present not more than 50 yards wide. The unpalatability of the bush is apparent from the way in which it remains undamaged among the few closely-cropped specimens of *Cliffortia linearifolia* and *Cliffortia paucistaminea.* The grasslands in the immediate vicinity are a transition between the sourveld and the sweetveld and indicate a rainfall of about 25 inches a year (see page 103). The conditions obtaining here appear to be the driest under which Passerina can exist, for away from the edge of the plateau the sourveld species are no longer found, and Passerina shows no sign of advancing into the sweetveld.

It is doubtful if this species can be distinguished without the inflorescence from *Passerina montana*, but the two may be told apart when in bud by the shape of the bracts.

Vlei Vegetation

The vlei vegetation could with justification have been included under the grasslands, for it will be shown that where the vleis are protected the grasses make up an appreciable part of the cover. However, the presence of a pure macchia community in the forest vleis, and the absence of a pure grass community in any, throws the balance rather towards their being treated together with the macchia, and this arrangement has been adopted accordingly.

Odd bushes of *Cliffortia serpyllifolia* may be seen in both the lowland and the highland macchia, and commonly in seepage areas. The species is sometimes co-dominant on the plateau west of West Peak Pirie with *Pteridium aquilinum* round springs and along the banks of small streams, but the largest communities so far found are in three small swampy glades in the Wolf Ridge Forests, each a little less than an acre in extent. Here the Cliffortia is 6 to 7 feet high and its density may be judged from photograph 57. It is dominant to the exclusion of all other woody plants except *Rubus* spp., a very little *Erica brownleeae* and some dead or dying forest trees. One or two hummocks are high enough to have a dry soil, and they bear the normal vegetation of the surrounding forests; in the Cliffortia community the ground is oozy, with a black, peaty appearance. Various sedges are common everywhere among a rich ground flora in which the following genera are well represented: Blechnum, Cineraria, Geranium, Impatiens, Kniphofia, Mentha.

It is strange that this species of Cliffortia should be absent from a similar swampy area at Hunterstoun, on the plateau about a mile south-east of the Hogsback hotel. As it has been recorded from the top of the Amatole range at 6000 feet (Story No. 3668) it is certain that the climate at the Hogsback is not too severe for it. It cannot be a question of shelter, for the area is surrounded by an unbroken ring of pine plantations, nor can it be due to fire or grazing, for the ground has been protected from both for about 30 years. The constrastingly open appearance of this vlei by comparison with the forest vleis is shown in photograph 58, but it has nevertheless certain similarities in the presence on the hummocks of Rubus and a little *Erica brownleeae*, and in the abundance of the sedges, which here completely dominate the ground flora. *Helichrysum fulgidum*, *Kniphofia* sp., *Leonotis leonurus*, *Nidorella auriculata*, *Zantedeschia aethiopica* and various forest ferns are scattered throughout, together with small communities and individuals of the grasses *Anthoxanthum ecklonii*, *Miscanthidium capense*, *Pennisetum macrourum* and *Pentaschistis* sp., the whole forming a dense cover and giving rise to a thick mat of decaying vegetation on the surface. *Cliffortia linearifolia* and *Pteridium aquilinum* also grow among the Rubus and Erica on the mounds.

The appearance of a vlei in the ministerial grazing is shown in photograph 59. Trampling and grazing between them have cleared away all the tall growth and all the litter. What remains is a closely grazed collection of small mounds, about a foot high and a foot across, separated by a network of drainage channels. The reason for this peculiar formation appears to be bound up with the grazing, for the protected areas do not show it, and it is probably caused by the way in which cattled tend to avoid the large and coarse tufts of vegetation at the expense of the smaller stuff between them, which provides easier going and better grazing. The resulting drainage is a very serious matter, the drying of the soil and denudation having in some cases gone far enough to permit the establishment of *Helichrysum argyrophyllum* on the mounds. This is now being arrested by the fencing of the vleis in the Native areas and the ministerial grazing, and the resulting changes in the cover are likely to be spectacular and to have far-reaching results. The vegetation at present consists almost entirely of sedges, the commonest being species of Scirpus and Tetraria. *Juncus lomatophyllus* is usually dominant near the lower end of the vleis where there is an abundance of soft mud and slowly-moving water. As at Hunterstoun, *Cliffortia serpyllifolia* is absent, and the other macchia shrubs practically so, nor is there any sign of macchia invasion.

SUMMARY:

INTERRELATIONS OF THE WOODLAND TYPES

TYPE 1

The relationship of type 1 (*Acacia karroo*) to the driest scrub, with a rainfall below 15 inches, has already been discussed. Acacia is found only in localised areas where conditions are specially favourable, and is clearly a post-climax community. There are no examples of this dry scrub in the district for the rainfall throughout is too heavy.

Where the rainfall is higher but where the habitat is in other ways unfavourable to the easy development of the mixed scrub of type 2, the Acacia persists as dense consocies, the succession slowing down in proportion to the unfavourable factors. It appears that the most important of these is exposure to wind, for the reasons discussed in chapter 4.

In type 2, which has a rainfall of 23 inches or thereabouts, there is ample soil water for the needs of Acacia, and it forms an integral part of the scrub.

It is not a constituent of types 3 to 5. Because of their deeper shade, it can grow only on their margins and in their glades, in the role of a pioneer (see page 65). The tendency is for these types to spread by extending their margins and by encroaching on the glades—*Acacia karroo* thus occupies an area which is constantly dwindling in size, and in the absence of disturbance it must in time disappear more or less completely. At Round Hill (page 104) it may be particularly clearly seen that Acacia is more xeric than these types. It occupies the northern slopes to the exclusion of other trees, but on the mesocline there is mixed bush approximating type 4. The two aspects are shown in photographs 4 and 5.

Types 6 and 7 are not associated with the Acacia in any way.

TYPES 2 TO 6

Types 2 to 6 in order occupy regions of increasing rainfall and are often in contact with one another, each with the lower limit of the one above it.

TYPE 7

Type 7 (the macchia) is associated with the forests (types 5 and 6), but is never found inside them.

Around type 5 it grows usually at the upper limits of the forest—at Lenye Forest Station for instance its first appearance is on the plateau where the plantations are, at an altitude of 3200 feet.

Forest patches falling under type 6 may have macchia at the top and bottom, and examples of this occur on the hills between Charybdis and Evelyn Valley.

It is noticeable that the forests occupy the steep slopes and the sheltered basins rather than the plateaus, flats and ridges, which are usually under macchia. This observation will be found to hold good in all the forest country, but there is a further point to be noted with respect to the highlands at about 4500 feet and over. This is that the forests become increasingly sensitive to exposure as the altitude increases. There is a definite timber-line, often coinciding with an escarpment, and above this one finds the forests absent except as shreds in deep gorges or in the shelter of piles of rock. The macchia, on the other hand, is by comparison little affected, and continues as a flourishing community to the summit of the Amatole range. The grasslands often accompany it, as is discussed in chapter 4. At the lower altitudes, the macchia acts as a pioneer to forest (page 79), above the timber-line it rarely does so.

CHAPTER 3

GRASSLANDS

GENERAL

It must be emphasised that tree growth may be found in places throughout the grasslands, and that there is no forest, however dense, which does not harbour a few grasses among its undergrowth. It is thus only for convenience' sake that the grasses and trees are at first considered separately. Their inter-relations are discussed in chapter 4.

An examination of the aerial photographs is alone enough to establish beyond question the importance of the grasses in the Keiskammahoek district. As they are found over areas in the lowlands and on the mountains, one would expect communities to differ in accordance with the large variations in their habitat, and an examination shows that in fact they do, and that they fall naturally into two great classes. The class in the warm areas with a low rainfall is known as the sweetveld, that in the cooler and wetter areas as the sourveld, and the dividing line between the two is between the 25-inch and the 30-inch isohyets. This is a general rule not only at Keiskammahoek but throughout the country generally, as may be confirmed by a comparison of the rainfall map (Department of Irrigation, 1939) and the vegetation map (Acocks, in press).

The names are unconnected with the usual conceptions of sweet and sour and for that reason are meaningless, but as they are so widely known and as there are no alternatives, they are being used in this paper. Many writers, among them Sim (1894), Pentz (1938), Irvine (1941), Scott (1949) and Acocks (ms.) have recognised these two types and have dealt with them from various points of view. There are different forms of sourveld and sweetveld, but they have a number of characteristics in common and the remarks which follow are applicable to all.

The essential feature distinguishing the two classes is that the sweetveld remains palatable during the winter and the sourveld does not. Throughout the year, cattle may be maintained in prime condition in the sweetveld without supplementary feeding, in the sourveld they fall off in condition as autumn approaches, and this no matter what bulk of the natural grass is available to them. Similar conditions have been described also for Natal by Pentz (1938, pp. 9, 13). There is as yet no satisfactory explanation for the short-lived palatability of the sourveld species. Sim (1894, p. 13) states that the reason is because "the very wide range of temperature between morning and midday during frosty weather is such that the herbage is suddenly rendered worthless and unpalatable, and gives much less nourishment than when it is dried off naturally by dry weather", but this view is untenable for the reason that the sourveld extends down towards the coast into localities where frost is practically unknown. Additionally, Figure 2 shows that the temperature range is greatest at Fort Cox and Lenye in the sweetveld zone and least at the macchia and Helichrysum stations in the sourveld zone.

The sourveld consists of tall bunched grasses vigorous in growth, in the sweetveld the grasses are often smaller and low-growing. Cynodon and Digitaria have the habit of spreading by means of runners more than by seed, and by their high frequency they are able to lend this character to the sweetveld as a whole. It is incorrect, however, to state that the development of stolons is common among the different sweetveld species. In the Border area at any rate there are only a few others of which this is true—*Tragus koeleroides*, *Danthonia curva* and *Chloris virgata* are the examples which come to mind. The first two are uncommon and *Chloris virgata* has the habit only weakly developed.

The sweetveld is almost always mixed with thorny scrub, the open grassland being so restricted that in the vegetation map of the Union (Acocks, in press) it is treated as part of the Valley Bushveld instead of being shown separately. The sourveld at Keiskammahoek is for practical purposes the same as the Highland Sourveld of Acocks's vegetation map, and as may be seen in the Transkei, there are often huge areas of it which are devoid of woody growth. Where trees and shrubs do grow in it, they are not thorny. The Keiskammahoek macchia and forest patches are examples.

It appears for the following reasons to be a simple water relation which determines whether the veld is sweet or sour.

1. The sourveld is always associated with a high rainfall, as has been pointed out, and its habitat, although often drier than is immediately apparent (page 123 and those following) is probably wetter than that of the sweetveld.

2. At the upper limits of the sweetveld it is often found that rocky outcrops and boulder-strewn hills support sourveld species. By picturing a piece of ground with rock outcropping over half its area, one may understand that practically all the rain falling on the rock will run off and wet the ground, and that the ground will in effect receive double the rainfall of the surrounding area. This theory is mentioned in *The Farmer's Weekly* of 2nd February 1949 (a quotation from Klintworth in *Farming in South Africa*), and is a likely explanation of the stony islands of sourveld which may be found in the sweetveld plains of the Orange Free State along the main road between Colesberg and Johannesburg. In size they are sometimes as little as a few square yards and may contain only one or two sourveld representatives. Similar islands occur on the Themeda plains of the Grahamstown commonage, where the following grasses have been observed: *Eragrostis capensis*, *Eulalia villosa*, *Festuca scabra*, *Harpechloa falx*, *Trachypogon capensis* and *Tristachya hispida*. These species are not found in the vicinity where the ground is level and free from rocks.

   The remarks on the islands apply only if the soil is deep enough for grass to grow. If it is too thin, it dries out very rapidly after rain and xerophytes alone can maintain a footing in it. *Lithops leslei* is an example from the northern Orange Free State, and *Microchloa caffra* and *Aristida* spp.; near Grahamstown *Euphorbia valida* is common together with the grasses mentioned.

3. Sandy soil is the rule over wide areas of the Bathurst and Alexandria districts, extending from Martindale southward. An anomalous spot is Round Hill, near the siding of that name on the railway between Grahamstown and Bathurst. It is an island of loam in an area of sand, and the geological map (Department of Mines Geological Survey 1946) shows that two geological systems are involved. The vegetation is likewise different, for the loam supports sweetveld species only and the surrounding sandy flats support the sourveld species listed in paragraph 2. A similar relation on a larger scale is shown by the absence of the sourveld species in the Standerton, Bethal, Heilbron and Vrede districts, where the sward is an exceptionally pure standard of *Themeda triandra*. The rainfall is over 25 inches a year and hence is theoretically adequate for sourveld, or at least for a sprinkling of sourveld species, such as occurs respectively on the northern border of this area and on the eastern border of the Orange Free State, both with the same rainfall. The difference lies in the soils, which are a heavy black turf in the Themeda area, and which are lighter where the sourveld is.

The evidence is that where the rainfall is between the needs of sweetveld and sourveld, a light soil will throw the balance in favour of the sourveld, and conversely. An explanation is to be found in the higher water-retaining capacity of the heavy soils (Maximov, 1929, p. 63). This makes them a physiologically drier habitat in which the moisture-demanding sourveld species cannot thrive. In the physiologically wetter sandy areas, however, their water-requirements can be met, and they are able to compete successfully with the sweetveld species. Clements (1934, p. 49) reports that in America also "probably the most dramatic, as certainly heretofore the most puzzling, compensation for desiccation has been that afforded by sand hills and sand plains."

It is ignorance of this which has given rise in *The Farmer's Weekly* to much uninformed criticism of the article by D.W.G.S. (1949, pp. 46–51), in which he mentions the former layer of sandy soil over the surface of the karroo, and ascribes to its recent removal a great deal of the deterioration which has since taken place in the karroo vegetation. Whether the sandy soil was there or not is a matter which geologists could best decide. If it was, there is little doubt that it could have supported a more mesophytic type of vegetation.

SWEETVELD

COMPOSITION, AND EFFECTS OF GRAZING

In dealing with the bewildering number of forms which the sweetveld can assume, one is faced with two main variables which must be taken into account: rate of stocking and climate.

Most of the sweetveld has been overstocked for many years and has in the course of time changed out of recognition. The worst areas are bare and thus possess the one essential feature of a desert.

Areas less heavily stocked are thinly covered by shrubs and a growth of Cynodon, and their vegetation corresponds in form closely to that of the karroo. There is a relation in species composition too, but it is the inedible or at least unpalatable elements of the karroo flora which are most strongly represented, and it is difficult to attribute the disproportion to anything other than that the nutritious species are kept out by uncontrolled grazing. The commonest shrubs are *Chrysocoma tenuifolia* and *Aster muricatus*. *Chrysocoma tenuifolia* is poisonous and may cause heavy losses in parts which have been denuded (Steyn, 1934, pp. 393–406) such as these artificially induced karroid areas invariably are. A contributory cause of a karroo-like appearance to the veld is a weedy growth of *Selago corymbosa*. It is avoided alike by all kinds of stock, and from the manuscript reports of Dyer it is plain that this plant is another response to uncontrolled stocking. He found that "by resting camps and allowing grass to grow, nearly all the young plants are killed apparently due to the effect of shading." Although in the Albany district there are farms heavily infested with this shrublet, it is only of minor importance at Keiskammahoek.

Under improved conditions the grasses assume dominance. At first the cover is sparse and poor in grazing value, a ragged mixture of *Cynodon*, *Aristida* and *Eragrostis* spp. *Themeda triandra* is scarce and in certain places is all but unknown. Sometimes its disappearance is complete enough to suggest that it never was a native in certain places, for example along parts of the road between Fort Beaufort and Alice, but the vegetation along the neighbouring railway track reveals the true state of affairs.

The best sweetveld areas are marked by an almost pure stand of *Themeda triandra*. Karroo bushes are absent, and by comparison with the sourveld the non-grasses are in general uncommon.

An examination of the sweetveld according to the climate reveals an analogy between the effects of rainfall and rate of stocking, that is, low rainfall causes a diminution in the amount of Themeda with a corresponding increase in the proportion of *Digitaria*, *Sporobolus*, *Eragrostis*, *Aristida* and *Cynodon* spp., and with progressing dryness the change continues through karroo to desert.

These observations may be summed up thus: the better the conditions of grazing, or the higher the rainfall, the greater the proportion of Themeda in the sward.

Optimum conditions are represented in the cemetery at Keiskammahoek, which is grazed only occasionally and where the rainfall averages about 24 inches a year. The grass cover is shown in photograph 60, and quadrat figures are given in Table 34.

In protected areas *Panicum maximum* grows only where the ground or the vegetation has been recently disturbed, and it does not mix with the Themeda. Along the railway line, for instance, it grows on the embankments, and in the Keiskammahoek cemetery it grows along the edges of the paths and on the graves. This shows that it is low in the succession, and it is therefore at first somewhat surprising that it should be a rarity in parts where grazing is uncontrolled. It is found where it is protected by scrubby tree growth, but Mr. E. D. Matthews (page 56) has pointed out that it is well capable of growing in the open, as is shown on old fallow lands on his farm. He is of the opinion that its general absence in clear spaces is simply because it is prevented by the stock from growing there. Its palatability and its upright habit are certainly a fatal combination and support his view.

OTHER COMMUNITIES

ORNITHOGALUM THYRSOIDES

Some of the variations from the usual changes induced by uncontrolled grazing warrant special mention. A spectacular and well-known example is from the immediate vicinity of Keiskammahoek—*Ornithogalum thyrsoides*. When the plants come into bloom in the early summer they are a very striking sight, and an idea of the appearance of the veld may be gained from photograph 61. Their thriving condition and their abundance make it difficult for the layman to believe that they are a recent invasion related to overstocking, but there are several strong arguments in favour of this. They may be briefly stated as follows:—

1. Photographs taken by Mr. E. D. Beale to show the Ornithogalum and dated Christmas 1923 are not of the area where it is now most common, but were taken some distance out of town, one on the road to Chatha Forest Station and the other on the road to St. Matthews. Copies of the photographs are in the files of the Botanical Survey Section, Grahamstown. Although it cannot logically be inferred from this that there was no Ornithogalum nearer the town, there is a probability that this was so.

2. Dr. R. A. Dyer has mentioned that in about 1926, when he was working on the Helichrysum experiment described by Schonland (1927), Ornithogalum grew on the slopes of Bumbane Hill, but there was none round the town itself.

3. On 3rd November 1948, belt transects of 4 x 108 yards were done in the cemetery (rarely grazed), in the camp on its south border (closely grazed) and in the unfenced part north of the cemetery, which is an uncontrolled thoroughfare for stock (severely overgrazed and trampled). The Ornithogalum plants totalled 77, 994 and 4760 in order from the lightly grazed to the most heavily grazed area. This gives an average number of

TABLE 34

POTENTIAL COMPOSITION OF SWEETVELD

A. Woodland Type 1 (Keiskammahoek Cemetery). Square metre quadrats

Species	Quad 1	Quad 2	Quad 3	Quad 4	Quad 5	Quad 6	Quad 7	Quad 8	Quad 9	Total
Anthericum sp.					0·02					0·02
Chaetacanthus setiger ..					0·01					0·01
Crabbea nana			0·01	0·01						0·02
Digitaria eriantha				0·01		0·04	2·43		0·11	2·59
Eragrostis capensis ..	0·01				0·31			0·11		0·43
Eustachys paspaloides ..				0·35		0·09				0·44
Helichrysum nudifolium ..				0·17	0·03	0·01				0·21
Hermannia sp.						0·01				0·01
Indigofera sp.			0·11		0·07			0·01	0·02	0·21
Oldenlandia amatymbica ..						0·01				0·01
Pelargonium reniforme ..		0·01		0·01			0·01			0·03
Rhyncosia sp.		0·02		0·06	0·01		0·20	0·01	0·01	0·31
Senecio retrorsus		0·02								0·02
Sporobolus fimbriatus ..								0·02	0·04	0·06
Tephrosia sp.			0·09		0·01			0·03		0·13
Themeda triandra	13·48	7·95	6·03	7·60	8·81	5·75	5·93	8·53	9·28	73·36
Thunbergia sp.							0·01			0·01
Tragus koelerioides ..							0·01			0·01
Vernonia sp.		0·10		0·04	0·07					0·21
Indeterminable					0·01		0·01	0·01	0·27	0·30
	13·49	8·10	6·24	8·24	9·36	5·91	8·60	8·72	9·73	76·39

Average Basal Cover 76·39/9 = 8·49 per cent.

TABLE 35

POTENTIAL COMPOSITION OF SWEETVELD

B. Woodland Type 2 (Protected ground at Fort Cox). Square metre quadrats

Species	Quad 1	Quad 2	Quad 3	Quad 4	Quad 5	Quad 6	Quad 7	Quad 8	Total
Abutilon sonneratianum					0·05				0·05
Aizoon glinoides								0·43	0·43
Aristida bipartita		0·45		0·72		0·09	0·58		1·84
Brachiaria serrata		0·16	0·02	0·93	0·64		0·02	0·18	1·95
Digitaria eriantha	2·18	0·01	4·17	8·75	0·02	8·18	9·06	0·48	32·85
Helichrysum sp.					3·97	0·01			3·98
Hypoxis sp.						0·01			0·01
Panicum maximum					3·18				3·18
Phyllanthus maderaspatensis			0·01					0·02	0·03
Sedge					0·08				0·08
Senecio burchellii							0·01		0·01
Setaria perennis							1·85	15·39	17·24
Sutera atropurpurea				0·03		0·03			0·06
Themeda triandra	18·80	14·10	11·66	0·36		8·82			53·74
Indeterminable						0·01		0·01	0·02
	20·98	14·72	15·86	10·79	7·94	17·75	11·52	16·51	115·47

Basal Cover 115·47/8 = 14·43 per cent.

plants to the square yard of 0·17, 2·30 and 11·0. The dense infestation of the surroundings contrasts strangely with the cemetery. While it is evident that infestation is encouraged by heavy stocking, there is a limit to this process, and beyond this limit the correlation breaks down. A transect along a wide cattle-path showed in figures what was plain to the eye, and what is merely axiomatic, namely that an extreme amount of disturbance will inhibit the growth of these plants. The path in question is about 16 yards wide, covered in Cynodon and slightly sunken. There were 208 plants in the transect, or 0·48 to the square yard. It is the mechanical effect of the trampling alone which prevents the plants from becoming established, and not exposure to the sun. This is indicated by the way the young seedlings come up in hundreds in completely denuded areas—in fact, strong light appears vital to them because they are never found in dense mixed scrub or under shady Acacia trees.

Ornithogalum thyrsoides is a stock poison (Steyn, 1934, p. 517) but is a potential danger only in the summer for the reason that the above-ground parts (leaves and flowering culms) die back when flowering is over. Steyn's information that it causes losses mainly when mixed with hay and that it is very rarely eaten under natural conditions is confirmed by the fact that no losses were reported from Keiskammahoek although the stock had free access to the heavily-infested areas when the plants were in the full vigour of their growth.

The species has the means of spreading rapidly if there is a favourable combination of the circumstances mentioned. Flowering may be delayed or suppressed by drought, but in a good year begins in early October and the young plants as well as the mature ones take part. The culms are usually from 12 to 15 inches in height, but even the two-inch culms of plants a few seasons old can produce reduced spikes of normal flowers. They continue in full bloom for six weeks and over, then the flowers rather suddenly come to an end, the leaves wither away and the culms alone are left standing, bleached and papery. Counts showed that the average plant produced about 28 flowers and that each flower produced an average of nearly 46 seeds. A square yard of a badly infested area might at this rate be expected with one crop of flowers to drop over 14,000 seeds. They are wind-distributed. The persistent capsules dehisce at the top, and with the shuddering movements which the wind produces in the rigid culms the seeds are sprinkled around as from a minute pepper-pot. They are a deep but dull black, the size of a pinhead and sharply angled. They are mature a few weeks after they are shed, probably even earlier than this, and may be stored for a year at least without any lessening of their viability. The first signs of life may appear on the third day after the germination test is begun, thereafter germination may continue very irregularly for ten weeks and more to a total averaging 92 per cent.

Ornithogalum thyrsoides has not been seen in the sourveld.

BULBINE ASPHODELOIDES

The land round the town which is now occupied by Ornithogalum was until 1928 at least under a thick growth of *Bulbine aphodeloides.* I have seen five different photographs taken with a view to illustrating this fact, and they suggest that the show of flowers was something out of the ordinary and a sight worth recording. One of the photographs is reproduced (photograph 62). On the original photograph, a note by Dr. R. A. Dyer states that *Bulbine asphodeloides* had been spreading rapidly in the last few years on the town commonage and Native settlements, and was becoming a "serious menace to the grazing capacity of the veld." Although it is still to be found in this vicinity, the plants are now so thinly scattered as to be scarcely noticeable, and the reasons for its former complete dominance and its subsequent disappearance are at present inexplicable. In other parts of the district it is still present in patches several morgen in extent, of which the best examples are at Gwili-gwili and Gxulu. It has conspicuous heads of yellow flowers which were in bloom in 1949 from January to March.

THE TRANSITION ZONE

As with the woodland types, the transition in the grasslands from one type to the other is gradual. From the surroundings, the ecotone between the sweetveld and the sourveld may be recognized by the composition of the neighbouring woodlands (which are typically between types 3 and 4) and the scarcity of Acacia and the large, clean-stemmed habit of such Acacia as does exist. The pasture resembles the sweetveld proper in its domination by *Themeda triandra*, but scattered individuals of the sourveld species begin to make an appearance. It is mentioned in the account of type 4 that the first ones are likely to be *Harpechloa falx* and *Tristachya hispida*. Others slightly less common are *Eulalia villosa*, *Koeleria cristata* and *Alloteropsis semialata*. Usually the closely-cropped condition of the sward makes them difficult to recognize, but *Hyparrhenia buchananii* is another safe indicator of the transition and its coarse flowering culms often escape being grazed so that the plant may be recognized more easily. It is very rare in the sweetveld where it can sometimes live precariously if it is protected from the setbacks caused by grazing and trampling. One or two plants grow in the Keiskammahoek cemetery, but no others have been seen in the vicinity, the rainfall of which averages about 24 inches a year. Even in the transition zone, it does not occur extensively, and favours the banks of streams and dongas more than the open veld. It thins out rapidly as it nears the sourveld itself, and finally disappears near its borders.

The scraps of Hyparrhenia represent in a very attenuated form the Tall Grass Veld described by Pentz (1938) and Acocks (in press). Where the Tall Grass Veld attains its best development is in Natal, and there it forms a broad and irregular belt between the sweetveld—shown as Eastern Valley Euphorbia Scrub by Acocks—and the sourveld. It appears again in smaller quantities forming a buffer between these two veld types in the Transkei, but diminishing towards the south until in the Ciskei it is no longer of sufficient extent to be shown separately.

Elyonurus argenteus is not found until the upper limits of the sweetveld are reached, and its first appearance is therefore another indication of the transition zone. Unlike Hyparrhenia, however, it is a component of the sourveld throughout. Though widespread and common in the Union as a whole wherever the rainfall is over about 25 inches, it is in the lower parts of the Keiskammahoek district curiously patchy in its distribution. Except when it is forming new growth, animals avoid it whenever possible on account of its strong taste. It therefore does well where grazing is uncontrolled and heavy, being stimulated by a certain amount of incidental disturbance from the stock but receiving no serious check from grazing and finally giving rise to a tussock veld like the example shown in photograph 63. The trampling mentioned, as long as it is not excessive, contributes to the healthy growth of Elyonurus, for if protected from disturbance it has a propensity for dying out after accumulating a mass of leaf which appears to smother the parent plant The dead tufts rot through at ground level and come away very easily with wind or rain or trampling.

Conditions round the town are probably too dry for Elyonurus and so far none has been found there except near the western limits of the golf course where some low-lying ground collects the run-off from a ridge to the south, and is in addition occasionally flooded when the river is in spate. The slightly increased dampness of the ground is apparent from a scattered growth of *Andropogon appendiculatus*, *Artemisia afra* and *Rubus* spp., and Elyonurus is one of the grasses in this community.

COMPOSITION, AND EFFECTS OF GRAZING

The sourveld consists in its most typical form of a mixture of grasses similar to those occurring from Stutterheim through the Transkei to the Natal highlands, described by Acocks (ms.) as Highland Sourveld, and shown in photograph 64. In the Keiskammahoek district it is now found only on about 200 morgen on the mountains north of the house at Chatha Forest Station, and on the upper slopes of Mount Thomas, so that its area is negligible, but historically and potentially it is a very important veld type.

The upper limits of the sweetveld and the lower limits of the sourveld are often dominated by Themeda, commonly mixed with the following in varying proportions:—

Brachiaria serrata
Elyonurus argenteus
Eragrostis capensis
Eragrostis chalcantha
Heteropogon contortus
Setaria flabellata
Sporobolus capensis.

In respect of these species the two types are similar, but besides by the tests mentioned on pages 103–4 the sourveld may may be distinguished by the presence of one or more of the following grasses:—

Harpechloa falx
Tristachya hispida
Alloteropsis semialata
Andropogon appendiculatus
Trachypogon capensis
Koeleria cristata
Eragrostis caesia
Sporobolus centrifugus
Aristida galpinii
Aristida junciformis
Eulalia villosa
Panicum ecklonii
Panicum perlaxum
Digitaria diagonalis.

They are arranged roughly in order of frequency, those down to *Sporobolus centrifugus* being fairly well distributed, and those below being patchy or rare. None of them are found in the sweetveld. There is a wealth of corresponding non-grasses, but they vary so widely from place to place that it is felt inadvisable at this stage to arrange them in order of frequency, without excepting even the commoner ones that follow:—

Alchemilla spp.
Argyrolobium speciosum
Aristea schizolaena
Aspalathus spp.
Aster bakerianus
Caesia eckloniana
Centella glabrata
Cliffortia linearifolia
Cliffortia paucistaminea
Cotula hispida
Cycnium racemosum
Dobrowskya scabra
Erica brownleeae
Erica floribunda
Haplocarpha scaposa
Helichrysum spp.
Hypoxis argentea
Indigofera hedyantha
Leyssera gnaphaloides
Lightfootia huttoni
Lobelia erinus
Phylica galpinii
Relhania trinervis
Stoebe cinerea
Stoebe plumosa
Zaluzianskya capensis.

This Themeda-dominant sward referred to is low in the sourveld succession, consequently it is not a stable community except in the position stated—at the lower limits of the sourveld. Its dominance elsewhere in the sourveld than here is a sign of a change brought about by grazing animals. That is why Themeda is so common in areas reclaimed from Helichrysum. Schonland time and again emphasizes its abundance in the plot in the Gxulu commonage, and the same thing is evident at King's Nek today. Further protection brings about a gradual preponderance of the grasses peculiar to the sourveld. Whether this is desirable from the point of view of soil conservation and grazing could probably be established from results obtained at the Dohne Experiment Station.

The soil grows darker with increasing altitude and takes on a peaty texture. It is generally moist, with oozy places below the cliffs and round the edges of exposed sheets of rock. Particularly on the shady slopes, there is a gradual admixture of new grasses which by their abundant and rank growth hide the dips and hummocks and stones from view and give the veld a peculiar softened appearance. This appearance is misleading, for the grasses causing it usually have leaves harsh and pungent, and the grasses which are in reality soft are smaller and hidden from view. The following grass species are characteristic of the parts near the top of the Amatole range, but their relative frequencies are not sufficiently known to be stated:—

Agrostis barbuligera
Agrostis bergiana
Anthoxanthum Ecklonii
Aristida galpinii
Aristida junciformis
Brachypodium flexum
Bromus firmior
Bromus speciosus
Festuca caprina var. *irrasa*
Festuca costata
Festuca sp. nr. *Festuca caprina*
Pentaschistis sp. nr. *Pentaschistis juncifolia*
Poa binata.

The associated non-grasses in number and variety far exceed those of the lower altitudes, and the following list gives no more than a very general idea of those commonly found:—

Anthospermum aethiopicum
Anthospermum lanceolatum
Athrixia phylicoides
Berkheya decurrens
Cineraria deltoidea
Cineraria lyrata
Cliffortia eriocephalina
Cliffortia paucistaminea
Cluytia katherinae
Diascia rigescens
Dierama sp.
Erica alopecurus
Eucomis sp.
Geranium ornithopodum
Helichrysum spp.
Hypochoeris radicata
Lepidostephium denticulatum
Nemesia melissaefolia
Ornithogalum subulatum
Peucedanum capense
Restionaceae
Rubus spp.
Rumex sagittatus
Scabiosa tysonii
Selago galpinii
Senecio paucifolius
Tritonia lineata
Wahlenbergia rivularis.

This mixture continues to the summit wherever there is a fair depth of soil, as there is on the ridge running from Mount Thomas towards the west. Along most of the escarpment's edge, however, there are outcrops of rock and consequently a thin and scanty soil, and in these parts there is a marked difference in the vegetation. All the grass species are present, but it is the Aristida species that predominate, and an irregular growth of *Arundinaria tesselata* occurs in the district nowhere else but among the piles of rock in this area. A scanty growth of dwarfed shrubs is remarkable for its similarity in the matter of hard mucronate leaves and a dense woolliness, and rosette plants, *Restionaceae* and succulents are well represented. The surroundings as a whole convey a sense of bleakness and desolation, and this is often heightened by the wind, for the peaks are in the path of every wind that blows.

The following are some of the plants characteristic of the area:—

Arrowsmithia styphelioides
Aspalathus spp.
Chrysocoma tenuifolia
Erica spp.
Euryops dyeri
Helichrysum spp.
Mesembryanthemum spp. (in the broad sense)
Muraltia macroceras
Phylica galpinii
Passerina montana
Ursinia apiculata.

On the north side this vegetation ceases where the rock dips below the soil, giving way to the gentle treeless slopes of sourveld in which the streams drain away into the Kei River. Peaty soil and the accompanying abundance of herbs and rank grasses are not a feature of the northern side, and in all essentials this sourveld is the homologue of that on the south side a thousand feet lower down, as is discussed further in Chapter 4. The sourveld passes gradually into the sweetveld at an altitude of about 4500 feet, Happy Valley post office being on the border between the two. Most of the veld in these surroundings no longer shows any trace of sourveld species. Themeda is the dominant grass, associated with a great number of karroid non-grasses like *Lycium oxycladum*, *Eriocephalus* sp., *Cotyledon orbiculata* and *Aster muricatus*. It is only in protected places where a few specimens of *Harpechloa falx* remain to indicate the veld's true affinities.

The peaty soils at high altitudes on the south side are soft and easily damaged by trampling. They wear into deep paths, and where the underlying rocks are close to the surface whole sods may come away, leaving a face of ground without support to form a starting-place for extensive erosion. The harm is aggravated by the invariable steepness of these parts. From Geju Mountain on 4th November 1948, sixteen landslides could be counted in the upper Mnyameni basin, varying in length from a few yards to many hundreds. The basin is wrinkled with paths, which give evidence of heavy stocking, and the outlines of new and old burns show that the vegetation is burnt irregularly and often.

OTHER COMMUNITIES

HELICHRYSUM ARGYROPHYLLUM

General

Below the region of friable soil it takes hard trampling in the sourveld to produce a bare area. Where trampling is not so heavy, and particularly on the xerocline, the grasses as they become weak and sparse are covered by a mat of *Helichrysum argyrophyllum*, which protects them from further injury. Clements (1935, p. 365) is of the opinion that "grassland binds the soil with roots as no other community does". In the Helichrysum areas most of the grass roots still remain, and there are the thick Helichrysum cushions over them to form a practically unbroken covering to the soil. As a protection, this combination is an effective one, and erosion in the Helichrysum areas as a whole is not spectacular. Gullies can form only where the community has been destroyed. There is a little tunnel erosion in different parts. The district is fortunate in having conditions suitable for this Helichrysum, which Schonland (1927, p. 6) has described as "a blessing in disguise". The most important observations presented in his paper are as follows:—

1. About 60 square miles were covered by this plant in 1923, in Keiskammahoek and the adjoining areas.
2. It owes its dominance to the destruction of the original grasslands.
3. It is a pioneer species and gives way to grass if the area is protected.
4. Grass can continue to exist beneath the mats it forms.
5. Burning destroys it, and grass will re-establish itself in 18 months if the area is burnt and then rested.
6. It forms a thick layer of humus which guards against erosion by holding soil and water.

There has been a further paper on *Helichrysum argyrophyllum* by White (1948), who confirms Schonland's observations. He estimates that there are now about 100 square miles infested by the weed, and by this clearly illustrates the steady deterioration of the Amatole pastures.

I have a few additions to make to these data, but no criticisms to offer.

Present Trends

According to a leader in the *Daily Dispatch* of 23rd August 1927, Helichrysum was causing anxiety about 1907, but occupied a relatively small area. White's observations on its spread are confirmed by photographs 65–6, taken respectively about the time Schonland's work began (1923 or thereabouts) and in 1949. At the present time, grasses growing through the Helichrysum are still able to supply meagre grazing to stock, but these relicts are becoming scarcer. In consequence the cattle are forced to go in search of food into the most remote and inaccessible parts of the district, where the same story is being repeated that had its beginning in the more populous parts of the highlands 50 years ago. Photograph 67 shows the cattle grazing a slope which has so far remained more or less untouched because of its steepness. Here and in this vicinity the grasslands are now gradually breaking down, those on the xerocline being the first to go, those on the mesocline lasting longer because of the better conditions which give them a stronger hold on life, and tending towards macchia rather than Helichrysum. The end either way is total destruction of the grass cover, and its progress may be seen in photographs 37–8. If these areas are taken in hand, it follows naturally that the time taken for a sward to become re-established will be longer on the xerocline.

Propagation and Enemies

The plants come into full flower near the middle of April, but for some unknown reason this takes place sooner on level ground and is delayed on slopes, irrespective of their aspect or area. On 8th April 1949 the Helichrysum was only just beginning to come into bloom, yet tiny seedlings were found that appeared to be not more than a week old. These could have arisen only from the seed of previous seasons, and show that the seed may lie for a year at least without germinating.

Its only biological enemy that has been noted is a species of grasshopper, associated with the Helichrysum and probably dependent on it for food, which may be inferred from the fact that it has so far not been seen on other plants. In size it is a little under half an inch and in colour a perfect match with the silvery sheen of the Helichrysum leaves. There are, however, not enough of these insects to constitute the slightest threat to the host plant, which yields its place only in the normal course of plant succession, or in the face of trampling or fire. Domestic animals will not touch it. Mr. F. J. Stayner, at one time District Forest Officer at Keiskammahoek, tethered a goat in dense Helichrysum near Schonland's plot in the early 1920's, supplying it with drinking water but no fodder. It refused consistently to eat the Helichrysum, and after it had voided any waste originally in its system it passed nothing more until the test ended after seven days.

Distribution and Requirements

So far, *Helichrysum argyrophyllum* has not been seen west of a line running north from Fort Beaufort. There is a reference in file M4 of the Botanical Survey, Grahamstown, to its occurrence on the farm Stockdale, which is 30 miles north-west of Somerset East in a direct line. Specimens from this farm were determined by the National Herbarium as *Helichrysum splendidum* and *Helichrysum argyrophyllum*, but although I have found *Helichrysum splendidum* on Stockdale, I have searched for *Helichrysum argyrophyllum* without result. The record cannot be substantiated, for the specimens in question were not mounted.

The Helichrysum does not flourish below about 3000 feet. Below this altitude it forms a patchy growth, and even this ceases altogether at about 2500 feet. The unfortunate consequences may be seen in the Mnyameni Valley. There is a carpet of Helichrysum on the upper reaches and bare soil lower down, with a resulting change in colour from white to red that is clearly visible from many miles away.

In this connection it is, however, worth recording that Dr. Schonland raised from seed and maintained for several years a small patch of *Helichrysum argyrophyllum* in the grounds of the Department of Botany, Rhodes University, where the altitude is about 1700 feet.

Although Helichrysum is a definite xerophyte (page 124), its occurrence on the south-facing slopes of the mountains running west from Mount Thomas shows that it is one of the many which are able to grow under mesic conditions. Usually, however, it is much less common on the mesocline, and the reason for this appears to be that the successionally advanced plants are able to maintain themselves more easily, and after destruction by fire or grazing, to re-establish themselves more quickly under the conditions obtaining there, and by their continued presence they deny the ground to it. Photograph 68 shows how grass remains in the moister hollows after it has been destroyed in the surroundings, and how the Helichrysum in consequence is unable to invade the sward. It will never oust grass unless the grass has been grazed heavily enough to lay bare the soil, and even under these conditions it is merely a temporary stage which will disappear as soon as conditions improve.

It will not exist under the unceasing trampling which takes place round Native settlements, cattle kraals and tracks, and when it goes there is no other plant able to take its place while those conditions remain. This is shown in photograph 69. If it is not kept out by mechanical means there is almost no bare area in the highland sourveld where it will not ultimately grow, and it will germinate and become established on rock, if the surface is cracked or uneven enough to collect a little soil. In heavily grazed areas it persists as a disclimax on all the upland slopes except those facing south, and on all the plateaus. Where the grazing is slightly lighter, even though still excessively severe if judged by generally accepted standards, the Helichrysum is gradually invaded and ousted by the macchia (see photograph 70).

Occurring only as patches on the crests of ridges, or on the bare soil of firebreaks, Helichrysum is rare between Mount Kemp and West Peak Pirie, even though most of the slopes face west and north-west. As these parts are above 4000 feet in altitude and are uncontrolled as to grazing, one would expect Helichrysum to be dominant. The two possible reasons for its unexpected scarcity are set out in the two preceding paragraphs. It was at first thought that the former explanation was the more likely one—that this area, by its nearness to Evelyn Valley with its 70-inch rainfall, might be in a zone wet enough to mask the effect of the sun and give rise to mesic conditions so that the Helichrysum would be suppressed by the resulting vigour of the successionally higher plants. To test this hypothesis, a rain-gauge was set up on the west slopes of Mount Kemp, 30 yards from the summit. The year's readings are given in Table 14, page 23, and show that the area probably lies outside the zone of heavy rainfall, and thus that the theory is untenable. It appears that Helichrysum has given way to macchia according to the latter possibility, and the aerial photographs of 1938 certainly show that the macchia was then far less dense, but whether the cover was grass or Helichrysum in the open parts it is not possible to say.

Control

Burning, followed by resting, will kill the Helichrysum and allow the grass to assume dominance. This was proved by experiment and clearly set out in Schonland's report 21 years ago. Helichrysum is not very inflammable but it is always possible to set it alight unless it is wet from rain or dew. On level ground and in calm weather it smoulders rather than burns, with flame only when there are gusts of wind or where there is an accumulation of trash in the path of the burn. The fire travels very slowly, sometimes less than 2 feet a minute. Generally it dies down of its own accord, for any small barrier in the form of a track or a sparseness in the cover is enough to check its spread. If there is a slope the speed is greatly increased because the draught is more in the direction of the burn instead of at right angles to it, and in such places, or where there is a wind, the fire is a much more extensive and rapid affair. There is always an evolution of dense white smoke with a Helichrysum burn which makes even the small ones conspicuous.

This indiscriminate burning is carried out by Natives during the winter to remove the protective covering of Helichrysum and to expose the remnants of the grass so that the stock may graze them more easily. The resulting seres, in all stages of development, give rise to strange and irregular deviations from the overall pattern of the vegetation which are at first a very puzzling feature of it. Depending on the fierceness of the fire and the subsequent grazing, the old burns may support almost any type of highland community, from sparse Helichrysum to macchia or grassland. Usually they are heavily grazed from the time the new shoots of grass begin to appear, and under this worst possible form of exploitation it is the bare ground that predominates.

When burning is done with a view to re-establishing grass, it is essential that a rest should follow to enable the grass to build up reserves and set seed. Grazing may be allowed in the winter after the seed has fallen, but should be discontinued before the coming of the warmer weather so that the seeds may germinate and the new crop of seedlings become established without hindrance. The rains, and the resulting green growth, make summer burning impracticable and this leaves a choice of burning in early, middle and late winter. Early and middle winter have the disadvantages of leaving the ground uncovered and vulnerable to erosion for too long a time, and of causing an out-of-season greenness which sooner or later becomes blighted by frost. An added objection to early winter burning is the possiblity of destroying some of the grass seed before it has been shed. These difficulties fall away if the burning is done towards the end of winter. It is felt that this should be carried out before the first rains, for the following reasons:—

1. The object is to get rid of the Helichrysum; accordingly a fierce burn is necessary and this is best attained by firing a dry and dormant vegetation.

2. Analyses done by Kotsokoane (ms.) show that Themeda is the commonest grass of the Helichrysum areas, with a basal cover ranging from 8·1 to 60 per cent of the total and averaging 32·3 per cent. Figures for the germination of a strain of Themeda from the eastern Cape (Gluckmann ms.) are as follows:—

	Alternating temps. 95°F day, 65°F night).	*Constant temps.*
Per cent germination after 1 day (24 hrs)	0	0
Per cent germination after 2 days (48 hrs.)	49	38
Per cent germination after 3 days (72 hrs.)	27	53
Per cent germination after 4 days (96 hrs.)	4	12
	80	78

From these figures it may be seen that unless burning can be done within 48 hours after rain, there is a risk of destroying the major part of the young Themeda plants by exposing them to fire when they are at their most vulnerable stage.

3. Burning before the first rains has been done at King's Nek, and the results have justified it (see photograph 71).

CHAPTER 4

THE RELATION OF GRASSLAND TO WOODLAND

REVIEW OF LITERATURE

Schimper (1903) and Clements (1905) deal between them with aquatic, woodland, grassland, alpine, arctic and desert vegetation. With the exception of the arctic, all are represented in the eastern Cape, but in their importance woodland and grassland far overshadow the others put together. These two, as Schimper puts it (1903, p. 162) "stand opposed to one another." There is an unceasing tendency for each to encroach upon the territory of the other, and round the margins the balance is often so fine that imperceptible changes will cause one or other of the formations to be over-run. There are forest glades, for instance, and islands of woodland, which in their habitats and their history give no clue to the reason for their difference from the vegetation surrounding them. "The extraordinarily varied nature of the natural and semi-natural vegetation of most parts of the earth's surface, and the extreme complexity of the processes involved in its determination and change, render its correct interpretation a slow and difficult task" (Tansley, 1934, p. 317). This being so, there can be no simple answer to the straightforward question: What conditions favour woodland and what ones favour grassland?

What follows is a summary of the views held by other writers and a collation and a discussion of the facts so far observed at Keiskammahoek.

Clements's concept of the relation between grass and mesophytic woodland is given in his publication of 1934, page 45: "Grassland is preclimax to scrub and forest formations, while these are typically postclimax to it." One may assume that Clements uses the word *scrub* here in its usual sense of stunted tree growth. On pages 43 and 59 of the same publication, however, the word appears to be used in connection with desert shrubs, equivalent to the South African karroo bushes.

This concept was amplified in a personal discussion between him and Mr. R. Rose-Innes, in which Dr. Clements made a point of the strong competition which the grasses offer to the trees in respect of water. He was of the opinion that with a high rainfall, there was enough water for both, and the trees were able to get above the grasses and shade them out of existence. Where there was less rain, the relatively shallow-rooted grasses used the water before it had time to percolate and there was thus a drier subsoil that prevented trees from growing. With a rainfall of less than about five inches a year, trees could live by virtue of their longer roots which were able to penetrate to deep water supplies, but the grasses, unable to reach down so far and with insufficient rain to meet their requirements in the upper layers of the soil, could no longer exist as a formation. From dry to wet areas the picture is thus one of trees, grass and finally trees again. In a joint publication (Weaver and Clements, 1929, p. 460), the idea is expressed as follows: ". . . grassland occupies wide limits between climax forest and xeric scrub or woodland." The depth to which some roots can extend is illustrated by a letter dated 9th August 1948 in file BP 6 of the Division of Botany and Plant Pathology. The writer reports that roots, probably of *Acacia giraffae*, were found at a calculated depth of 150 feet in a borehole in South West Africa.

Clements's correlation of grassland and woodland with rainfall might answer if other factors were equal. As they never are, his hypothesis cannot be applied, at any rate not in a detailed study. This is shown by the fact that five rain-gauges, established in the mountain grasslands above the forests from the Hogsback to Mount Kemp, registered without exception a heavier rainfall than was registered at the forest stations on the same aspect below them (see Table 14, p. 23). Another example is given by Schimper (1903, p. 459) who records that the eastern grasslands of Uruguay and Argentina are moist, with a rainfall of 70–100 centimetres a year (27–39 inches). Further west the country is drier (40–70 centimetres or 15–27 inches) and is under woodland.

It is in addition not an invariable rule that grasses are intermediate between woodland and desert. This has been pointed out by Bews (1929, p. 291).

Clements's correlation is doubtless meant for application on a continental or even a world-wide scale, so large that the anomalies would be lost in the general picture. It is too wide to be considered in any other way.

Another difficulty in his theory is that he does not comment on the life cycle of the desert trees he mentions. It is understandable that they could exist by living on underground water, but it is hard to understand how the seedlings could establish themselves under very arid conditions. The seedlings are the most vulnerable stage of the plant, and the idea of their penetrating great depths of dry soil is manifestly out of the question. However, the fact remains that they do find a way of circumventing this difficulty—not only trees, but other deep-rooted desert plants also. A well-known example is *Acanthosicyos horrida*, an aberrant member of the *Cucurbitaceae* growing in the sandy wastes near Walfish Bay. A description of it is given by Marloth (1932, p. 205), and notes on its life-history are to be found in a paper by Versfeld and Britten (1915, p. 234). Versfeld and Britten suggest that "when a seed germinates in damp soil in which the water gradually subsides, the young roots will naturally extend deeper and deeper in search of water." It is not clear whether their meaning is that the soil is dampened by showers, and that the roots keep pace with this rain-water as it percolates. If this is their meaning, the supposition as it stands is untenable because of the extremely rapid growth-rate which it postulates for the roots, and a modified and more acceptable form of it is advanced by Shreve (1917). From his studies at the Desert Laboratory, Tuscon, he concludes that the establishment of desert perennials is accomplished by their entering a state of dormancy during the dry spells, and by their taking advantage even of meagre showers to put on spurts of growth. Of *Parkinsonia microphylla* he states: "A seedling which has reached a height of 20 centimetres has done so by a fortunate development of its root-system, and by withstanding from 20 to 40 years of the fluctuating conditions of the desert climate." The rainfall at the Desert Laboratory is about 14·60 inches (Shreve, 1914, p. 10).

Michelmore (1939) has made interesting observations on the relations of woodland and grassland in Africa generally. He regards these observations as showing that seasonal or permanent waterlogging of the soil is of prime importance in denying an area to tree growth. This rule is capable of very wide application, and the trees which are not affected by waterlogging appear as a rule to be highly specialised. The most familiar examples are the Taxodium species of the Everglades (Willis, 1919, p. 639) and the *Rhizophoraceae* of the tropical mangrove swamps (Marloth, 1925, p. 222).

Support for Michelmore's observations is provided by Gleason's paper of 1912, which contains a description of a wood seasonally flooded, but with the trees always about two feet above high water mark. Burtt Davy (1922) gives a striking photograph of the Vaal River near Christiana where the same state of affairs is apparent. The trees at the edge of the running water and those well away from it are separated by an open, nearly level belt where conditions are apparently rendered unfavourable to the trees by the lodging of soil water. The work of Griggs (1936) in the sub-arctic Katmai district also shows that trees avoid the poorly-drained soils and grow rather near hillocks, streams or sunken tracks carrying off the water in the immediate vicinity. It is not water in itself, but stagnant water which inhibits tree growth. Perhaps the most convincing evidence is that given by the treeless marshy areas found in the Wolf Ridge forests and described on page 100 of this paper.

But Michelmore's application of this concept to bare plateaus is open to question, for the upland plateaus at Keiskammahoek are rolling, so that the excess water is carried away by a shallow but definite system of drainage lines. On page 295 he states in support of his drainage theory: "Where steep and stony hills arise from such an open plateau, they are nearly always wooded." There are numerous examples of this at Keiskammahoek, and one is shown in photograph 52. The gradient of its sides is roughly 25 degrees. If drainage were involved, it would follow that plane slopes as steep would also support trees, but this is not so. There are plane slopes above the Chatha forests where the gradient is up to 38 degrees, and they are regularly without trees. Michelmore does touch upon this difficulty, and suggests that the soils remain too wet for trees in spite of drainage. This explanation is surely inept if wooded hillocks and grassy plane slopes are found under similar conditions, as the Keiskammahoek examples are. In addition, the aerial photographs show as a general rule that buttress slopes separating wooded valleys are treeless. Michelmore, in claiming that the valley sides are well drained and hence provide suitable conditions for trees, does not explain these bare "knife-edges", which have ground falling away steeply on three sides, and consequently a drainage far more effective than the valley sides where the fall is in only one direction. It is difficult also to reconcile his theory with the almost invariable presence of trees on hills in areas of the karroo which are otherwise under karroo-bush. One might with reason assume that the drainage question falls away here on account of the scanty rainfall in these parts.

The answer is perhaps to be sought rather in Schimper's theory (p. 121) regarding exposure to strong winds, in which matter plateaus, plane slopes and "knife-edges" are most affected.

Phillips (1934, p. 238) states that fires inhibit tree growth, and "the keeping out of fires . . . has certainly resulted in the development of woody scrub of various kinds in South Africa and in East Africa."

Clements (1934, p. 59) reports the opposite from America: "In the great majority of cases, fire increases the dominance of scrub at the expense of grass." It has been pointed out that there is a certain amount of ambiguity connected with Clements's use of the word *scrub*, but here Mr. R. Rose-Innes has been able to confirm that tree growth is meant. He reports a discussion as follows: "Clements says that with the exception of the pines, about 90 per cent of all American trees will sprout again after having been burned down. His statement is that fire increases woody growth, even though it does *appear* to destroy it."

So far, I have found writers on African vegetation unanimous in agreeing with Phillips (1934) that fires destroy woodland, and clear evidence for this theory may be seen in an old burn scar in the Chatha forests, shown on the map and conveniently viewed from the slopes about two miles north-east of the forester's house. A closer examination shows that the original forest trees have been killed, and that the regrowth is not from coppice shoots but from seedlings, a state of affairs in direct conflict with Clements's observations on American trees. There is thus little doubt that African trees, as distinct from those in America, can be killed by fire. Nevertheless, this statement requires qualification. The tests mentioned on page 52 show that the effects of fire on some trees are dependent on the heat evolved, while other trees, like *Xymalos monospora*, survive "enormous forest fires" (Sim, 1907, p. 288), and very little information is available on this subject, particularly in respect of scrub species.

Another puzzling aspect of the problem is the presence of trees along the railway line between Fort Beaufort and Kingwilliamstown, in spite of the fact that the track is bordered by abundant grass which is set alight at intervals by sparks from the trains. This train service dates from 1904. One cannot blink the possibility that there may be trees which can withstand a certain amount of burning even in the seedling stage, and without experimental data to go by it is dangerous to apply the general rule too widely.

Further evidence for the resistance of the local trees to fire was obtained from a farm in the Fort Beaufort district. A fire broke out on 1st January 1950 on a hillside covered with bush equivalent to woodland type 3. It was extinguished after it had burnt an area of about an acre. The burn was examined on 22nd April 1950. Most of the ground was still bare, some of it scorched black or red, and no seedlings were noticed except one of *Acacia karroo* and a number of a grass which appeared to be *Panicum maximum*. *Oxalis* spp. were regenerating from the underground parts of old plants and not from seed, and were fairly common. Of the trees, a little more than half appeared to have been killed. Nearly all of those alive were shooting from below the surface of the ground, the exceptions noticed being *Euphorbia tetragona* and *Ptaeroxylon obliquum*, which were making new growth from severely scorched trunks. Individuals of the following species were shooting:—

Allophylus decipiens
Asparagus spp.
Brachylaena sp.
Calpurnia sylvatica
Commiphora caryaefolia
Cussonia spicata
Ehretia rigida
Euphorbia tetragona
Fagara capensis
Gelonium africanum
Grewia occidentalis
Gymnosporia buxifolia
Gymnosporia undata
Hippobromus pauciflorus
Pavetta capensis
Plumbago capensis
Ptaeroxylon obliquum
Rhoicissus cuneifolia
Royena cordata
Schotia latifolia
Scolopia zeyheri.

The burn was visited for the second time on 14th February 1951, to see if any regeneration had since occurred from those stumps which had appeared to be dead when the first visit was made. A thick tangle of herbaceous vegetation covered nearly all the ground, concealing all but a few of the stumps. Climbing plants were dominant, and smothered large patches under a luxuriant growth. Common ones were:—

Asparagus spp.
Coccinia quinqueloba
Helinus integrifolius
Melothria punctata
Senecio tamoides.

Of the non-climbers the commonest were:—

Atriplex semibaccata
Gnaphalium sp.
Panicum deustum
Plumbago capensis
Senecio juniperinus
Solanum spp.
Xanthium spinosum
Zinnia multiflora.

Because of this matted vegetation, it was not possible to make any further observations on the survival and growth of the trees, and only time will tell with what speed and success their regeneration will take place. The preliminary observations, however, make it plain that burning need not necessarily result in their total destruction.

Schimper (1903) goes into the demands of the two formations in greater detail. He defines grassland requirements as:—

1. Frequent rains, particularly in summer. The rain need not necessarily be heavy (p. 173).
2. A supply of superficial soil moisture (p. 173).

3. A mild summer temperature (p. 553).

Hostile to grasslands are:—

1. Summer temperatures by day constantly greater than 86°F or 30°C (p. 173). The English translation of Schimper's work is ambiguous here, and the original German text equally so. One cannot tell from either whether average or maximum temperatures are meant.
2. Drought in spring and early summer (p. 174).

Woodland requirements are:—

1. The continuous presence of a supply of water within reach of the extremities of the roots (p. 166). This, however, is not in accordance with the findings of Rawitscher (see p. 93 of this paper).
2. The predominance of calms over windy weather (p. 555).

Hostile to woodlands are:—

1. Strong winds, especially in the dry season (p. 277).
2. Cold dry winters (p. 456).

CONDITIONS AT KEISKAMMAHOEK

The Forest Climate

An examination of the existing conditions in the Keiskammahoek forests shows that Schimper's theoretical requirements for woodland are met in full. However, his grassland requirements are met no less fully by this same forest climate, and the soundness of his theory is demonstrated by the way the grasses freely occupy all areas where the original forests have been cleared (photographs 23, 28). The layman would naturally and with good reason ask why, since the environment is suitable for both, grassland and woodland do not strike a balance and exist together in the form of parkland. The answer to this question is given by the fundamental ecological law that the climax community of a succession is the one "that terminates in the highest life-form possible in the climate concerned" (Clements, 1936, p. 261). The highest life-form of all is tropical forest, and it is towards this ideal that all successions tend (Wells, Huxley and Wells, undated, p. 661; Bews, 1920, p. 388; Phillips, 1931, p. 204).

Treeless Areas at Low Altitudes

Nevertheless, the forests are not unbroken, nor are the tracts of scrub and bush. There are large areas of grassland below the timber-line, often mixed with trees but usually pure on flats, plateaus and on the tops of ridges (see photographs 72–4). These exposed patches of grassland in otherwise wooded country are the rule in the Union, and there is a note by Aitken (1922, p. 210) on bushy slopes in Natal, with grasslands "on the less steep slopes and on the flatter terraces." The same thing is reported by Rehmann (quoted by Schimper, 1903, p. 601) from south Russia, in the transition zone between steppe and forest. Forests are associated with valleys and ravines, and do not usually go beyond them, and the "large tracts of flat ground that lie between these river valleys and ravines are entirely free from forest." References by Gleason (1912, pp. 38–49) from America indicate that there is a world-wide tendency towards this relationship between the two formations.

In seeking a reason why these particular parts are not wooded, one may safely rule out the possibility of an inadequate supply of soil water. The bare flats round the Keiskammahoek boundary on the road to Debe Nek, for instance, must receive a yearly average rainfall of over 30 inches, if one judges by the Rabula data, and even springs on them are without trees, provided they are not in kloofs or hollows.

The influence of cold dry winters in excluding woodland at lower altitudes must also be considered. Cold is shown to be of minor importance by the presence of trees in dips and hollows and along streams, in the very places where cold air drainage at night would be most likely to cause frost pockets (Whitmore, 1949). If cold were instrumental in encouraging the grass, the gently rounded plateaus and the tops of ridges would be under trees, because such places provide good atmospheric drainage and no lodging-places for the cold air. A very strong argument that cold does not enter into this question comes from areas near the coast. Frosts are a rarity near Round Hill in the Bathurst district, for example (p. 104), yet even here there is the same relation of grasslands to the topography (photographs 4, 5, 72). Bare parts are also unconnected with winter drought, for they occur on level ground even at Evelyn Valley (photograph 73), where the winter rainfall averages over 3 inches a month (Table 13, p. 22). It is therefore unlikely that the winters are cold and dry enough below the timber line to be a force hostile to woodland, and thus the trees probably have no more than the one unfavourable agency of wind to overcome. This is in agreement with their absence in the parts mentioned, which are the ones exposed to the wind's full violence, and with their presence where the country is broken or where isolated boulders provide them with shelter (photograph 75).

Their absence in some of these unfavourable habitats does not appear to be a permanency. It may be not that trees cannot establish themselves in them, but that they establish themselves only with the greatest difficulty. This point is discussed more fully on page 92 and those following.

Treeless Areas at High Altitudes

There is a more or less sudden end to the forests towards the tops of the mountains, an occurrence common throughout the Union, and reported also from tropical Africa by Michelmore (1939). It is extensive enough to suggest that it is not a chance happening and that there is some cause for the general absence of forest trees at the higher altitudes. A consideration of Schimper's woodland requirements indicates that in the matter of water the supply is at least as good as that in the forests themselves, in the winter probably better because of the occasional falls of snow and the frequent mists which are more a feature of the Amatole highlands than of the forests. The highlands, however, are colder and are subject to strong winds. Temperatures are set out in Tables 2–8, pages 8–14; for the winds no figures are available, and reliance is placed instead on observations, and on the established fact that winds are stronger at the higher altitudes (Schimper, 1903, p. 701). It was observed that the highlands were more windswept by far than the lands supporting forest growth. The differences were unexpectedly large. On 23rd January 1950 there was a south-west wind blowing across the Amatole Basin on to the Wolf Plateau. Its force was 6 on the plateau, as measured by the modified Beaufort scale given in the meteorological notebook of the Division of Meteorology. In the Schwarzwald immediately below and to windward, it caused only the slightest movement in the treetops, a force of 3. During a strong wind on 18th August 1949 the wind-force was 3 round the borders of the Chatha forests and at distances 200 yards away and over the force was 7. It is during the dry season that the strong winds are most likely to occur, and it is during the dry season that winds are most unfavourable to forest growth. It is also noteworthy that tongues of forest in protected valleys extend into the mountains far above the general timber-line, and that they extend to the greatest altitudes in the most secluded valleys. According to Schimper's theory therefore it appears as though it may be the cold winter with the accompanying strong winds which keeps out the forests on the upper mountain slopes.

These indications of the injurious effects of wind are supported by the writings of various authors besides Schimper. Beard (1944, p. 144), Belyea (1925), and Maximov (1929, p. 267) emphasise the importance of winds as desiccating agents. Marloth (1908, pp. 341–6) gives photographs of wind effects, mentioning in his discussion that they sometimes bring about the death of trees. There is a clear picture of wind-pruning in the paper by Griggs (1938, p. 548), and on page 556 he puts forward a strongly supported argument that the cessation of woodland at high altitudes is due almost entirely to wind, stating that severely windy conditions may depress the timber-line by as much as 1500 feet. Braun-Blanquet (1932, p. 157) correlates a number of vegetation boundaries with prevailing winds.

Low-growing plants are also adversely affected. Russell and Wellington (1940, p. 176) quoting Kreutz, state that the growth of cabbages has been increased 300 per cent by shelter from strong winds. As a rule, however, the bad effects of wind are diminished near the ground because the force is less. At a height of 50 feet the velocity is about twice that at 6 inches (Schimper, 1903, p. 76). It is partly as a result of this that grass can continue growing where the wind keeps out the taller woody growth.

ALTITUDINAL DROUGHT

Although in the Border area at least, winds appear to be the greatest influence in denying an area to trees, their mechanical effects are not very severe at Keiskammahoek. The wind-pruning which is so noticeable near the coast is seldom seen, and although a spell of wild weather litters the forest floor with twigs and leaves, and blows down some of the older trees, there is never any wholesale destruction of the forests. Even on the exposed highlands the winds are seldom strong enough to cause breaking or uprooting of the macchia, and some of the macchia grows up to 12 feet and more. It is mainly as desiccating agents that their effect is felt, for they cause "a vast increase in transpiration" (Schimper, 1903, p. 168). It does not at first seem possible that winds could offset the advantages of the obviously well-watered Amatole highlands, with their abundant streams and large marshy areas and their cool and misty climate. It must however be remembered that the mountain winds are more violent, and that the parching winter winds in particular, which reach gale force at times, are in their effects likely to be most unfavourable to the growth of forest trees. Such winds can produce rapid wilting even with adequate soil water (Maximov, 1929, p. 286). In addition, they are aided by other forces, and their combination gives rise to a habitat which, free water notwithstanding, becomes in effect dry at certain times. Probably the first to apply this concept of drought induced by altitude was Schimper (1903). He clearly recognised its existence even though he did not have at his disposal all the facts which physics has since made available to later workers.

An important influence is the frost, which is a commonplace above the forests during any winter. The freezing of the soil is mentioned in the chapter on climate. Like hot dry soils, cold wet soils give rise to physiological drought (Warming and Vahl, 1909, pp. 194–5), and this drought increases with a lowering of the temperature until the soil water freezes, at which point soil moisture becomes totally unavailable to plants. The matter is discussed also by Maximov (1929, pp. 85–6) and Beard (1944, p. 133).

This is not to say that high temperatures do not come into the picture as well. They plainly do, and their telling effect is apparent from the increased numbers of xerophytes on the high northerly slopes (photograph 38). Temperatures are correlated with solar radiation, which is intensified at high altitudes becauses of the rarified atmosphere which allows a freer passage to the sun's rays (Schimper, 1903, p. 701). This factor is regarded by Maximov (1929, p. 154) to be of paramount importance in its effect on transpiration. It is particularly strong on the xerocline, being proportional to the light, which increases with the angle of incidence of the sun's rays. As to the actual rate of increase, opinions vary. Clements's figures (1905, p. 59) are:—

Angle of Incidence	*Light*
10°	17 per cent
90°	100 per cent.

Robbins, quoted by Aitken (1922, p. 209), gives:—

Angle of Incidence	*Light*
10°	33·4 per cent
90°	100 per cent.

Plants may be able to avoid the effects of solar radiation to a certain extent by setting their leaves with their edges towards the sun. It is however not known to what degree the local ones do so, if in fact they do so at all.

Bews (1917b, p. 525) remarks that evaporation at higher altitudes is greatly increased owing to the diminished atmospheric pressure. It is likely that this may be connected with increased transpiration, but as the relationship is complicated by other factors (Maximov, 1929, p. 169), the likelihood has not yet been made a certainty.

The highland soils have a peaty character. There is general agreement among the authors cited by Maximov (1929, p. 89) that such soils are physiologically dry.

The effect of all the influences mentioned grows with the height above sea level so that the habitat becomes physiologically drier the nearer it is to the tops of the mountains. Compensation from heavier rainfall has effect only up to about 5000 feet, thereafter there is scarcely any increase with the altitude (Whitmore, 1949b). This may explain the observations of Staples and Hudson (1938, p. 7) that the rainfall in the Basutoland mountains was lower than they had expected, even taking into account the snow, and the fact that most gauges were in valleys.

The atmospheric humidity has an important influence on transpiration (Maximov, 1929, p. 154), and the mountain air is moister than that of the lowlands, as Figure 1 shows. But from this same figure it appears that the mountain air may be surprisingly little moister, and Michelmore (1947) reports similarly that there are only small differences in atmospheric humidity near evaporating bodies of water and far from them.

XEROPHYTISM

General

Before considering the effect of the highland climate on the vegetation, it is advisable to discuss the term *xerophyte*, and a few of the characteristics of xerophytes. The word having been used loosely by many writers, notes have been written by Thoday (1933) and Carpenter (1938) in an attempt to bring order to the confusion. The definition given by Maximov (1931, p. 282) is followed in this paper: "Xerophytes are plants of dry habitats, which are able to decrease the transpiration rate to a minimum when under water deficiency." They are distinguished by their capacity to survive long periods of drought and dehydration of their tissues without injury, or with only slight injury (Maximov, 1929, p. 281), but their transpiration is not of necessity low at all times, and many of them can and do transpire heavily when circumstances permit.

Although they are xerophytic, they need not necessarily be xerophilous. They may be forced out of wet habitats simply because of the competition of more vigorous mesophytic plants, and not because moisture is harmful to them. One might cite in illustration a parallel case from the animal world. The Bushmen are today found only in the wastes of the Kalahari, but this race is not precluded from living in the moister regions by anything more than the fact that it has been exterminated there.

Before Maximov's work was generally known, it had been assumed that transpiration in xerophytes was always low, no matter what the habitat conditions might be, and so firmly established was this theory that Maximov's work was at first scouted by many physiologists. In the evidence he presents in support of his theory, Maximov omits one very pertinent point, perhaps, after direct experimental proof, the most telling one of all. The point is that it is a law of nature that organs which are not used by their owners become in the course of evolution functionless and vestigial. This is discussed at some length by Wells, Huxley and Wells (undated, pp. 232–5, 268). For this reason, if xerophytes were plants in which the transpiration was always low, they would be likely to conform to the law by having fewer or degenerate stomata. Instead, they have a plentiful supply, fully functional, which may be protected by various intricate mechanisms from rapid desiccation. To put it anthropomorphically, if their object were to reduce transpiration, it would seem strange that xerophytes should go to the labour firstly of producing stomata and secondly of protecting them. This behaviour, however, is explained if one accepts Maximov's view that xerophytes uncover their stomata and transpire heavily when they have the opportunity. It is to their advantage to be able to do so when they may, for the anabolism of all the higher plants is bound up with their transpiration.

Morphologically, xerophytes are usually characterised by one or more of the following:—

Development of strengthening tissue in the leaves	(Salisbury, 1949, p. 517)
Rolling of the leaves with stomata inside	(Maximov, 1929, p. 61)
Hairiness	(,, p. 262)
Ericoid leaves	(,, p. 264)
Waxy covering	(,, p. 392)
Thick cuticle	(,, p. 392)
Succulence	(,, p. 392)
Reduction in size of leaf cells, and strongly developed venation	(,, p. 327)

As Illustrated in the Amatole Mountains

The last character was not investigated, but the frequency of the other characters in the vegetation of the Amatole range unmistakably confirms the severity of the mountain climate. At times, naturally, conditions are mesic, for example on the calm, warm days which so often follow the summer rains, and it is then that the tolerance of the xerophytes prevents their being harmed by the copious supplies of available water.

Succulence is shown by species of Crassula, Delosperma and allied genera, but this character is more pronounced in the drier parts of the Fish and Keiskamma river valleys. On the mountains, hairiness and ericoid leaves (with which is usually associated rolling of the leaves with the stomata inside) are the commonest characters, so much so that the others are entirely insignificant by comparison. *Helichrysum argyrophyllum* alone makes up 100 square miles of densely hairy vegetation in the Amatole mountains (White, 1948). That *Helichrysum argyrophyllum* has increased enormously in the past 50 years does not alter the fact that the mountains are its natural home. It was collected by Ecklon, probably on the Katberg, about 1830 (Schonland, 1927, p. 6; MacOwan, 1886, pp. xliv–xlv), and it is accompanied by something like 55 other species of its genus (Sim, 1894), all more or less hairy.

The area under ericoid vegetation (macchia) is at Keiskammahoek roughly three times that under Helichrysum, and the leaf-structure of *Erica brownleeae*, *Cliffortia paucistaminea* and *Cliffortia linearifolia* is shown in Figures 8–10. In *Erica brownleeae* the adaxial side of the leaf has very thinly scattered and short unicellular hairs, arising as projections from the epidermal cells. No stomata were seen on this side. The leaf being strongly revolute, the abaxial side is tucked away below the leaf edges, and it is in this sheltered channel that the stomata are found, additionally protected by a dense felt of epidermal hairs three or four times longer than those on the opposite surface. The stomatal apertures are minute, so much so that it is most difficult to find them in a transverse section. They are more easily located by stripping the epidermis, in spite of the trouble presented by the smallness of the leaf and the depth of the abaxial channel. The leaf is sensitive to changes in humidity, and sections placed dry under the microscope will alter shape and tend to straighten if breathed upon. The mechanism by which this is brought about is not immediately apparent. As the leaf dries, the edges come closer together and the hairs meet and interlock, and in this way the stomata become more and more cut off from currents of dry air. The adaxial side of the leaf has the epidermis divided by a septum running parallel to the surface.

The leaf of *Cliffortia linearifolia* is very like that of *Erica brownleeae* in shape and anatomy. There are similarly a few protuberances on the adaxial side and longer thickly crowded ones in the abaxial channels, but even the longest are little more than slight projections from the epidermal cells, so heavily cutinised that the central lumen is all but obliterated, and they are too short and broad to be classified as hairs. The structure is touched upon in a general way by Eames and McDaniels (1925, pp. 36–7). As the stomata are found in the channels (Weimarck, 1934, p. 168), the projections fulfil the same protective function as do the hairs of *Erica brownleeae*.

In *Cliffortia paucistaminea* the stomata are on the sides of the leaf (Weimarck, 1934, p. 169), although morphologically still on the abaxial surface, and they are protected by precisely the same type of projection as is found in *Cliffortia linearifolia*.

Except where the stomata occur, the leaves of all three species have a thick cuticle, which is a further xerophytic character.

It is often stated that macchia requires a winter rainfall, but this is not strictly correct. It is summer drought, lack of water in the growing season when it is most needed, which causes conditions too severe for forest and allows the less demanding macchia to grow.

An interesting xerophytic grass from the Katberg and Winterberg is *Danthonia disticha*, the leaf-structure of which is shown in Figure 11. There are no stomata on the abaxial side of the leaf, on the contrary there is a heavy lignification and a thick covering cuticle, suggesting that the loss of water through this side is negligible. Turning to the adaxial side, one finds that the folding of the leaf cuts off this surface from communication with the atmosphere except through the narrow slit which separates the margins of the leaf, and that the stomata are further protected from drought by being set in deep recesses. Nor is this the only device to guard against desiccation, for there are unicellular hairs which project across the recesses and interlock and which one may safely assume are able to reduce the movement of air currents to something very small indeed. At the bottom of each recess are several large epidermal cells with thin walls and an irregular shape. They resemble closely the cells described by Haberlandt (1928, pp. 559-60) in the leaves of certain xerophytic grasses, and probably fulfil the same function of folding or opening out the lamina according to the spells of dry and wet weather.

Festuca costata is another widely distributed xerophytic grass, occurring in extensive patches throughout the Winterberg and Amatole ranges (photograph 76 and Figure 12). It usually grows in quantity only from an altitude of 5000 feet upwards, and thus in the coolest and wettest part of the mountains. Its leaf, which is flat in wet weather, becomes tightly revolute when it is dry and by this means effectually cuts off all its stomata from the open air, for they are found only on the adaxial side, which is the inner face of the spiral. A secondary protection is afforded by the ribbing, which breaks up the adaxial surface into a great number of channels containing the stomata, shallow and wide when the lamina is flat but deepened with its rolling and narrowed to the merest slits. Three of four large epidermal cells in rows at the base of each channel probably have the same function as in *Danthonia disticha*. Cutinisation is heavy on the abaxial side and light over the assimilating tissue. All these characters, together with the strong girdles of sclerenchyma in the ribs indicate that this grass is excellently fitted to weather the droughts and high winds of the mountain ranges.

Danthonia disticha is common along the tops of the mountains forming the escarpment from the Aberdeen to the Victoria East districts, and is found mixed with the *Festuca costata* and *Themeda triandra* which constitute the veld type of the Drakensberg range from the peaks down to about five or six thousand feet above the sea. In places it is one of the most important grasses (West, 1951, p. 49). By referring to the vegetation map of the Union (Acocks, in press) the distribution of these grasses may be seen at a glance, and the presence in quantity of two pronounced xerophytes over the huge area of 8000 square miles on South Africa's most important catchment is the strongest possible support for the concept of altitudinal drought.

If the climate is dry, physiologically or otherwise, both below and above the mesic forest belt, why are the grassland and woodland species in these two dry zones so different? There are two answers to this question. Firstly, the difference is not quite as great as it appears at first sight, for some species do grow in both zones. There is a list on page 92 of the trees which have been found growing above the timber-line on the Amatole mountains, and it is repeated here with those marked accordingly which occur in the dry lowlands as well.

Bowkeria sp.	
Buddleja auriculata	
Buddleja salvifolia	karroo (Sim, 1907, p. 277)
Canthium ciliatum	
Cassine kraussiana	collected Alicedale (Cruden, 252)
Cassine tetragona	
Cussonia paniculata	karroo and semi-karroid scrub (Sim, 1907, p. 230)
Euclea undulata	frequent in the semi-karroid scrubs (Sim, 1907, p. 263)
Gymnosporia acuminata	
Gymnosporia buxifolia	on karroo kopjes (Sim, 1907, p. 186)
Halleria lucida	on karroo kopjes (Sim, 1907, p. 281)
Heteromorpha sp.	in the thornveld (Sim, 1907, p. 229)
Kiggelaria africana	in the karroo (Sim, 1907, p. 128)
Myrica sp.	
Osyris compressa	collected mountain above Commadagga (Burchell, 3327)
Podocarpus latifolius	
Rapanea melanophloeos	
Rhamnus prinoides	karroo kopjes (Sim, 1907, p. 179)
Rhus dentata forma *genuina*	Bothas Hill (Schonland, 1930, p. 38)
Rhus pyroides	various forms recorded from hot and dry places (Schonland, 1930, pp. 29–31).

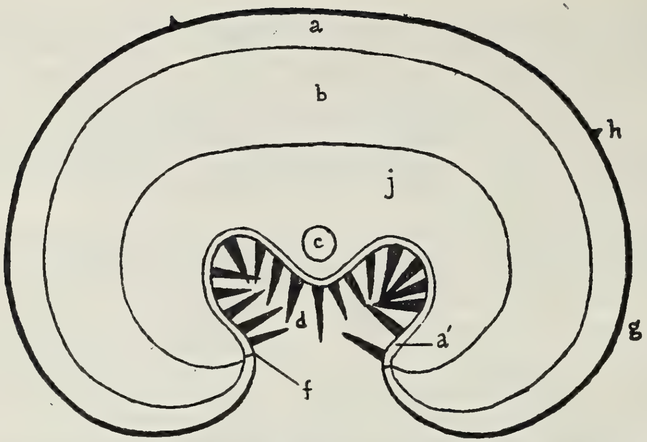


Fig. 8—Transverse Section of Leaf of *Erica brownleeae.* (Magnification 150).

a. epidermis, divided by a septum into two layers
a′. epidermis of smaller cells produced into long and narrow projections
b. palisade parenchyma
c. vascular tissue
d. recess in which stomata are situated
f. junction between lower and upper surface of leaf, marked by changing structure of epidermal cells
g. cuticle
h. scattered epidermal projections
j. mesophyll.

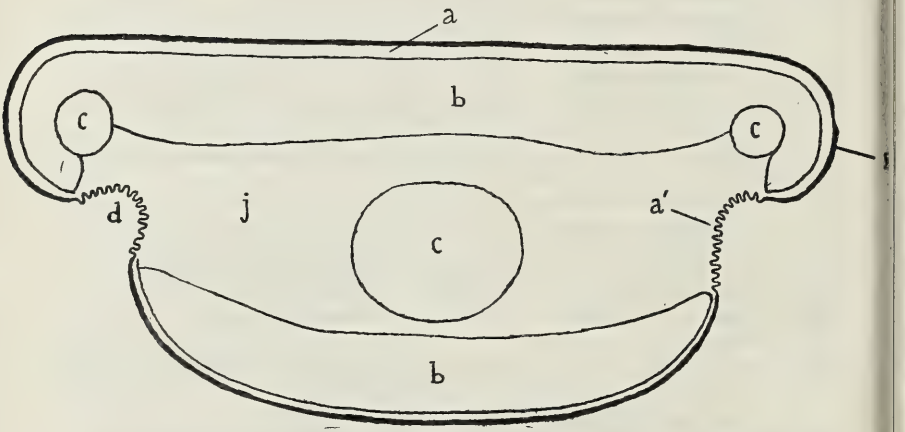


Fig. 9—Transverse Section of Leaflet of *Cliffortia paucistaminea.* (Magnification 250)

a. epidermis
a′. epidermis of ill-defined cells produced into heavily-cutinised projections
b. palisade parenchyma
c. vascular tissue
d. recess in which stomata are situated
g. cuticle
j. mesophyll

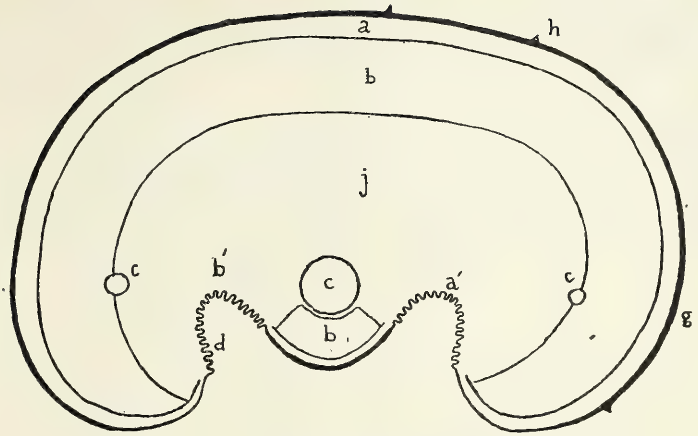
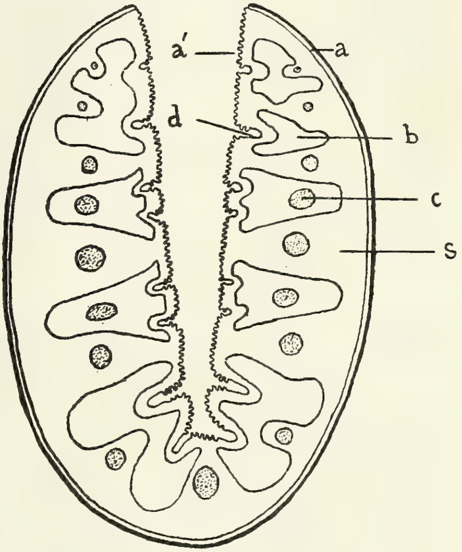


Fig. 10—Transverse Section of Leaflet of *Cliffortia linearifolia.*
(Magnification 225)

- a. epidermis divided by a septum into two layers
- a′. epidermis of ill-defined cells produced into heavily-cutinised projections
- b. palisade parenchyma
- b′. cells intermediate in form between palisade parenchyma and mesophyll
- c. vascular tissue
- d. recess in which stomata are situated
- g. cuticle
- h. scattered epidermal projections
- j. mesophyll

Fig. 11—Transverse Section of Leaf of *Danthonia disticha.*
(Magnification 85)

- a. heavily-cutinised epidermis
- a′. heavily-cutinised epidermal projections
- b. mesophyll
- c. vascular tissue
- d. recess in which stomata are situated
- s. sclerenchyma



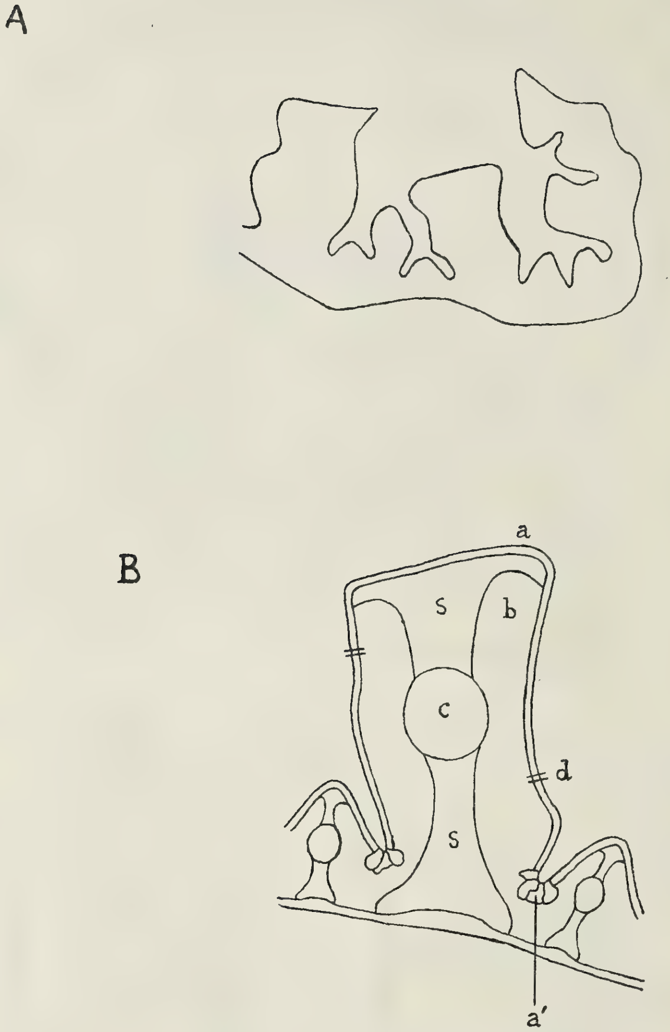


Fig. 12—Transverse Section of Leaf of *Festuca costata.*

A. Magnification 130, to show the shelter given by the broken nature of the upper surface

B. Magnification 300
   - a. epidermis
   - a′. modified epidermal cells of large size and irregular shape
   - b. mesophyll
   - c. vascular tissue
   - d. stoma
   - s. sclerenchyma.

Danthonia disticha provides another example of this double distribution, for it also is found in the karroid scrub. There are extensive patches of it growing among the karroo bush six miles from Grahamstown on the Cradock road, and it is recorded as well from similar country on the Fish River Rand, near Fort Brown.

Both woodland and grassland, then, have representatives in the two dry zones. That there are not more of them is probably because of the second reason, namely the temperature differences in these same zones. The influence of the temperature on the flora is mentioned on page 31. It is noteworthy also that the observation that thorniness is related to dryness (Bews, 1927, pp. 67, 75; Phillips, 1931, p. 135; Dyer, 1937, p. 90; Wells, Huxley and Wells, undated, p. 598) needs amplification. A *cool* and dry habitat is not characterised by thorny species. A *hot* and dry one is.

MACCHIA AND GRASS

Bews (1916, p. 145) subscribes to the view that grasslands are less mesophytic than bush, and this has been shown experimentally by McGinnies and Arnold (1939, p. 245). The physiological drought which has been discussed gives one an explanation of the cessation of forest growth on the higher slopes, and of the abundance of the grasses. The water-balance is more difficult to maintain, and the grasses can continue growing there because they are more xeric than the forests. This makes it clear that Clements's correlation of grassland and woodland with rainfall is in the right direction. It would, however, have been more readily understandable had he correlated the formations with available water, which may be a very different thing from rainfall.

But it is not only grass which grows on the Amatole highlands. The vegetation here is a patchwork of communities of macchia, grass and Helichrysum, and one is faced with the task of sorting out their relations with one another. The Helichrysum has been studied by Schonland (1927) and White (1948), who have shown that it is an invader which replaces the grasslands wherever they have been destroyed by over-grazing. It is thus merely an artificial community, and may be looked upon as potential grassland. This reduces the communities under consideration to two, namely grassland and macchia, and simplifies the work in hand. In their respective needs these two communities were found so closely akin that some difficulty was experienced in correlating them with the habitat factors. There follows a discussion of the points so far observed.

Firstly, there is a well-marked tendency for the grasses to linger on the xerocline long after the succession on the mesocline has reached the macchia stage. This may be clearly seen by an examination of the aerial photographs, and is also shown in photograph 77.

Secondly, the exposed and wind-blown places (plateaus, ridges and rounded hilltops) are usually more thinly covered with macchia, and have a correspondingly thicker grass cover than the steeper or more broken ground. This is evident throughout the highlands and is particularly well shown at the top of the right of way between the Wolf Plateau and the eastern boundary of the plantations of the Wolf Ridge Forest Station. The path leads out of the forest through a steep macchia-covered slope, and opens on to a plateau where the vegetation is open (Figure 13 and photograph 78).

Another clear illustration is at the top of the main Chatha valley, where a number of ravines under dense macchia are separated by grassy buttress slopes.

Thirdly, the water requirements of macchia are greater than those of grass. Grassland areas often contain localised wet patches where the water supply is sufficient for the growth of stands of macchia. Photograph 41 shows communities of *Erica brownleeae* covering the seepage areas below rock faces.

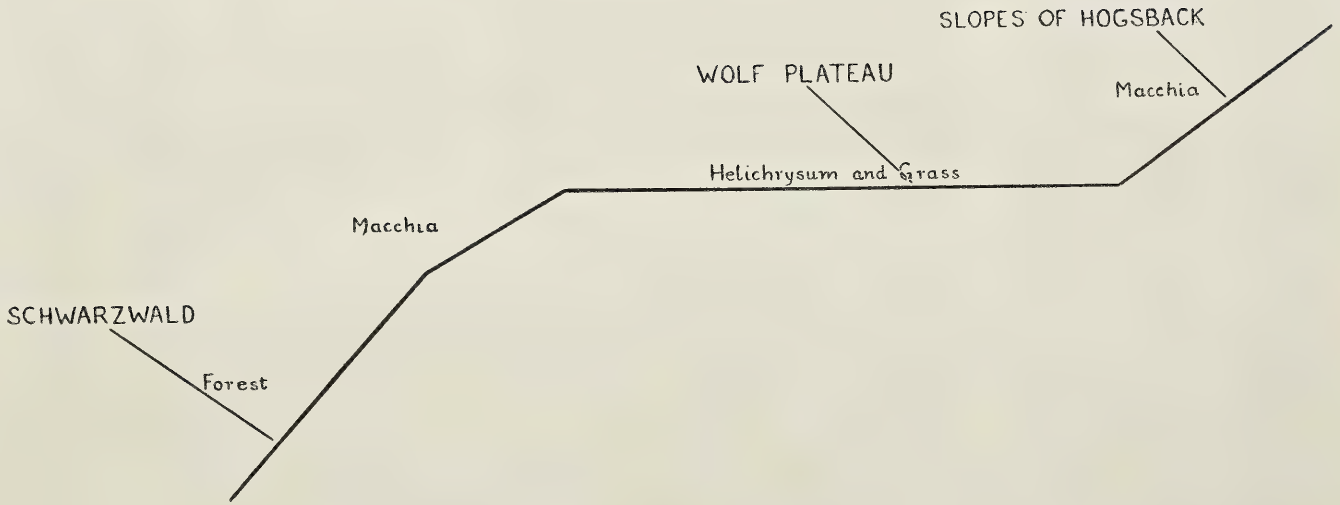


Fig. 13—Diagrammatic Section running North and South through the Wolf Plateau. (Not to scale).

Warming and Vahl (1909, pp. 210–11) also consider grass to be the more xeric formation of the two.

Fourthly, fire destroys macchia and encourages grass (page 90).

Fifthly, all the indications are that grass is in these areas low in the succession and a seral stage leading to macchia. The evidence for this has been fully discussed in Chapter 2, under the section dealing with type 7.

THE GENERAL PICTURE

The points discussed in this chapter lead to the following conclusions: South of the escarpment the forests occupy a zone which has a mild and wet climate. Below the forests the climate is hot and dry, and the vegetation thorny scrub. Above them the climate is cold and *in effect* dry, and the vegetation is macchia. Grass tends to occupy the wind-blown flats, ridges and plateaus in all three climatic zones. It is sourveld in the forest zone and above, and sweetveld below. In its essentials, the pattern of the vegetation is thus seen to be a symmetrical one, the forests being the centre of the system, and being flanked on either side by shorter woodland which has grass in its drier areas.

If the Amatole mountains continued upward to about 10,000 feet, the increasing severity of the climate would be likely to inhibit the growth of macchia, and grass, the more xeric type of vegetation, would probably be the climax. It is significant that in his account of the Drakensberg vegetation West (1951, p. 50) reports that at the summit (which is over 10,000 feet in altitude) "the macchia shrubs probably excluded by periodical fires are conspicuously absent". It may well be, however, that the highest parts are out of the macchia zone, and if this is so, West's alpine grassland is not a subclimax, but a climax. Marloth (1901, p. 163) reports the same disappearance of arborescent shrubs on the mountains of the south-western Cape. Here their limit is much lower, in the region of 4000 feet. In countries further south it is lower still. Dorrien-Smith (1908, p. 241) describes the Auckland Islands, south of New Zealand, as "heights 2000 feet high, in dense foliage up to 600 feet, and then a low scrub, till the grass line is met at 800 to 1000 feet".

To return to the Amatole mountains—if they continued higher, there would come a zone beyond which even the grasslands would be unable to extend, and where one would be likely to find the strongly xerophytic rosette plants, succulents and Helichrysum species that are now present among the rocks on the edge of the escarpment. These would continue up to the line of perpetual snow.

A brief description has been given on page 113 of the grasslands on the northern side of the escarpment. In the lack of definite evidence, it would be rash to assume that they are the climax in this region, but it can be confidently stated that they have a strong hold upon it. Macchia is absent, probably because of a combination of factors contributing towards the maintenance of a dry habitat. Baker (1944, p. 227) has shown that the rainfall is greatly reduced on the mountain slopes facing away from its direction of incidence. Sometimes the effect may be so sudden that the edge of the rain shadow coincides with the crest of the mountain, and the readings from the Mount Kemp raingauge (Table 14, page 23) suggest that this rule may be applied at Keiskammahoek as well. Potzger (1939) found that there was, in Central Indiana, 61 per cent more evaporation on the xerocline than on the mesocline. Where the slopes are gentle, as these ones are, there is little protection from wind. Gentle slopes permit also the lodging of cold air at night, whereas steep slopes give rise to rapid cold air drainage and consequently warmer conditions (Aitken, 1922, p. 208). Aitken's investigations (pp. 213–4) showed moreover that on the xerocline there was a slightly higher air temperature (higher by 6°F) and that the maximum soil temperature at two inches was twice as high and the holard half as high as it was on the mesocline.

Under these extreme conditions, macchia and forest are on the north slopes of the Amatole range found only where rocky outcrops present shelter favourable for their growth, and even then they are represented by nothing more than a few bushes and one or two species. As the river valleys deepen towards the north, the increased shelter and warmer climate permit the development of communities of mixed scrub and Acacia similar to those found in the lowlands to the south of the escarpment.

Figure 14 is a diagrammatic section running north and south through Keiskammahoek to show the relation of the communities with the climate.

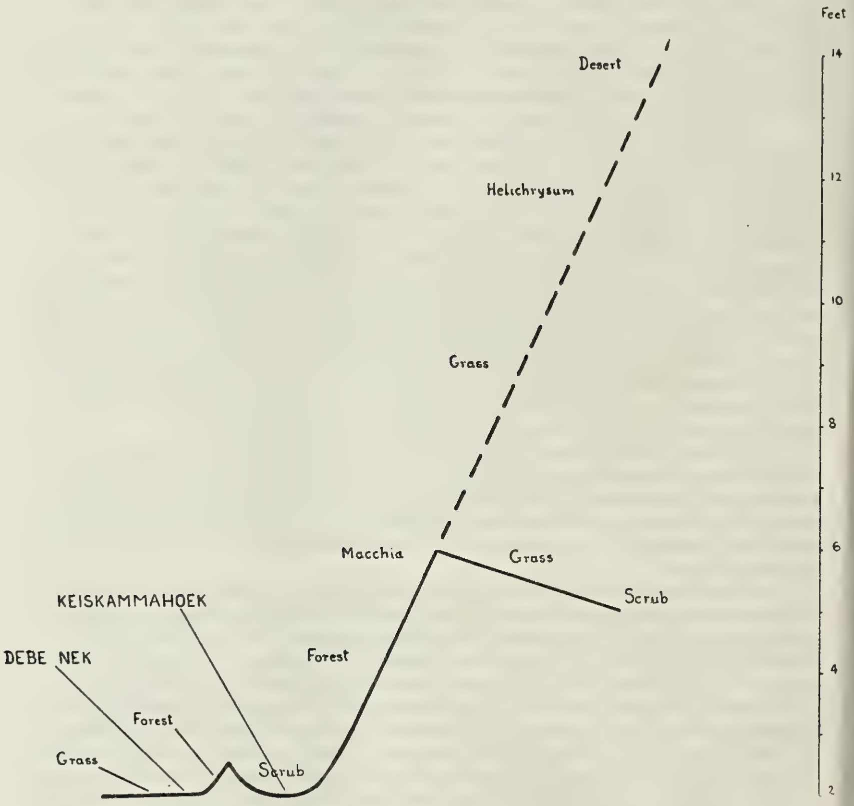


Fig. 14—Diagrammatic Section running from the Lowlands to the Highlands. Dotted slope hypothetical. (Simplified, horizontal scale reduced).

The vegetation map of the Union (Acocks, in press) shows on a much larger scale the same relation. It is best seen in the Transkei where there is no irregularly broken topography to complicate the climate and vegetation. The moist strip along the coast is Subtropical Coastal Forest. Above it in order are a strip of Coast Thornveld, the Highland Sourveld, which extends as far as the Drakensberg, and the Themeda-Festuca Alpine Veld of Basutoland. According to the evidence presented in this paper, these four veld types are in order of increasing xerophytism from the coast inland, and the underlying reasons appear to be as follows: The high rain and shelter in the Coastal Forest zone are each less in the Coast Thornveld (see Department of Irrigation rainfall map). In the Highland Sourveld there is as compared with the Coast Thornveld no great lessening of the rainfall, but the rolling country and the consequent exposure to wind make the habitat unfavourable for forest growth except where the hills provide shelter. On the Basutoland mountains the altitudinal drought exerts its influence, and here the most xerophytic type of the four is dominant. There is no anomaly presented by the Themeda in the alpine vegetation, for it is a very tolerant grass. It is recorded from most of the Union, including the dry western Orange Free State, with a rainfall of less than 15 inches.

Some workers are strongly of the opinion that the Highland Sourveld was originally temperate forest and that it has been destroyed by man. If the theory is accepted, the strip of Coast Thornveld presents a serious difficulty. Thorn is generally acknowledged to be a drier type than both Subtropical Coastal Forest and Temperate Forest. Why then would it be sandwiched between the two? There is no evident reason for this as far as the rainfall is concerned. Underlying geological formations may influence the vegetation (Mogg, 1929), but Prof. Mountain of Rhodes University informs me that there are no geological formations in this area which correspond even roughly with the Coast Thornveld. The strip of thorn presents a difficulty not only to those who hold the opinion stated, but likewise to those who regard thorn as a more xeric type of vegetation than grass, and for the same reason: why, in a reasonably even climate, would there be a strip of dry vegetation between two wet ones? That the thorn might develop into forest is beside the point, for its present relative abundance indicates that the area suits it better than do the areas towards the coast or those further inland.

The relative needs of grass, thorn and forest are clearly seen within a small area at Round Hill (p. 104). The disposition of the three communities is shown in photographs 4, 5 and 72. Woodland occupies the slopes of the hill only, the cooler south slopes being under dry forest and the northern ones under *Acacia karroo*. Assuming that Acacia is the most xeric community, one would logically expect to find a gap, under grass, between the Acacia and the forest, but the ring of woodland is unbroken. The grass is dominant only on the top of the hill and on the flats at its foot, and the evidence presented indicates that they are drier habitats than the slopes of the hill. The facts suggest strongly that the communities in increasing order of dryness are forest, thorn and grassland.

PRESENT TRENDS

All the woodland types are on the increase at Keiskammahoek except if the trees are being felled or if very heavy stocking is the rule, and more detailed notes on this tendency are given in Chapter 2, where the types are considered separately.

The Macchia

As far as the macchia is concerned, it has been shown that the increase n the highlands is very likely to be the re-establishment of a climax which has been destroyed by fire, and that below an altitude of about 4000 feet it is often a seral stage leading to forest.

The Scrub

Some workers have put forward the theory that scrub is increasing because of a climatic change towards drier conditions, and Wicht's figures (1949), which include the Evelyn Valley records, do show a downward trend in the

South African rainfall. This theory, however, postulates that scrub is a more xeric community than grass, and reasons have been given to show that the postulation is unlikely to be correct. An additional difficulty in the theory that scrub encroachment is bound up with decreasing rainfall is the contemporaneous spread of high forest, even in the face of a certain amount of grazing (see page 139).

If the reason *is* climatic, it may be sought rather in the season of the rainfall than in its decrease, undoubted though this may be. Possible causes of a shrinking of grassland and an advance of woodland, as given by Schimper (1903, pp. 174, 492, 548), are a dry early summer and thereafter irregular rain interrupted by dry periods. If there has been any change of this nature, however, it has not yet been proved.

Clements attributes the spread of Prosopis in the drier North American grasslands to the weakening of the grass competition through uncontrolled grazing. Evidence for a parallel in South Africa is given in the discussion of type 1 in this paper.

Although, as Dyer (1937, p. 55) has pointed out, the different kinds of game in the early days would have had a far bigger variety of tastes than the few kinds of domestic stock, their extermination does not account for the spread of woodland, for it has been reported from the Kruger National Park by Wolhuter (1948, p. 121). He states that Pretorius Kop during the Boer War was "not unlike the highveld" and was dotted about with fairly large trees, and that there has been a great increase of scrub since then, and of Dicrostachys in particular.

To sum up, the only acceptable theories for scrub encroachment are a change in rainfall seasons (for which, however, there is no direct proof) and heavy and uncontrolled grazing. Conditions in the Kruger Park cast some doubt on the grazing theory, but perhaps the balance between the animals has not yet become re-adjusted, for it was at first the policy to limit the carnivora without checking the game. Stevenson-Hamilton (1937, p. 270) states ". . . it is possible that the overstocked position today, which of course would not have occurred had normal rains fallen after 1925, might have been considerably ameliorated, and lions and other beasts of prey no more numerous than they now are, had we refrained, during the long period of twenty-five years, from conducting the 'thinning out' process". He states also (pp. 268, 270) that "of recent years, probably because they were affected by some canine disease, the wild dogs (Lycaon pictus) have almost disappeared from the southern regions of the Park, while the impala have increased so much that they have, in many cases, completely outrun their food supply, and have spread into areas formerly considered to be unsuitable to them . . . If wild dogs still existed in the numbers they did thirty years ago, I believe the impala would be in better condition, if less plentiful than they are".

The relation of grassland to scrub at Keiskammahoek was investigated as follows: On the ridges south-east of Burnshill are a number of old sneezewood stumps up to 24 inches in diameter. Figures kindly supplied by the Conservator of Forests, Kingwilliamstown, show that the fastest growth so far observed for sneezewood is an annual girth increment of 0·375 inches in the Alexandria forests. With this figure as standard, it may be calculated that the minimum age of the stumps is about 200 years. From the remnants of such old trees, and from the prints done by Bowler in 1864 of Fort Cox and Burnshill, which show the unbroken dominance of the scrub on the hills, it appears safe to take for granted that dry scrub or forest is the climax at Keiskammahoek wherever there is a broken or rugged topography to give shelter from wind.

These, however, are not the areas directly concerned in this discussion. Those that are, and that present most difficulty in interpretation, are the exposed positions (favouring grass) which from photographic and historical evidence used to support few trees or none, and where invasion by woodland is the rule (photographs 10, 11).

The absence of protected areas in such places presents great difficulty to the worker who is studying the succession. The tests of a climax, as set out by Weaver and Clements (1929, pp. 422–3) are of uncertain meaning. Apart from accurate historical records, there seems only one certain way of proving what the true position is, and that is by camping an area which will be guarded against fire and subjected to strictly controlled grazing. Complete protection from grazing is unnatural and will produce an unnatural result (Bews, 1929, p. 69; Weaver and Clements, 1929, p. 392; Story, 1939, p. 337; Henkel, 1947). To investigate the successional position of encroaching woodland, sites have been fenced near Grahamstown and at Keiskammahoek, in grassland, thorn scrub and mixed scrub, but as no conclusive evidence can be expected from these plots for many years, the best that can be done in the meantime is to discuss the rather fragmentary evidence that is available.

Here and in similar places the successional position of the scrub could be one of the following:—

1. It may be the climax. If so, these places are its true home, and it was growing there in quantity long before the Bantu arrived. The most obvious difficulty in this theory is to find an answer to the question: what caused the scrub to disappear? The influence of fire has been suggested, although it is usually expressed indirectly by the statement that the increase is due to the suppression of fires (Wolhuter, 1948, p. 121; Phillips, 1934; Galpin, 1926, p. 80). Fires in the early days did undoubtedly occur in the lowlands. An account of a fire in the lowlands of the Bedford district is given by Ainslie (1899, p. 136) as follows:—

> ". . . Spring Grove homestead was burnt in the 'sixties'. That was a most disastrous fire. It was a very dry season; the forest got ablaze and a strong wind spread the fire over the whole valley. The house had been re-thatched after the war; it caught fire, and the family had to take refuge in the middle of the ploughed land. Only the mill-house escaped the flames, nearly everything else being lost."

It has, however, been pointed out that the effects of fire upon dry scrub are still not fully known (page 119), and even on the assumption that fire does destroy scrub completely, it is reasonably certain that slopes would have suffered more than flats if it had been the agent, for the reasons given on page 116. Yet the Keiskammahoek slopes are under dense scrub today, and have been so for generations.

It has been suggested also that the Bantu cleared the scrub from the most accessible areas for cultivation or for fuel, or to provide for pasture for their cattle. Bews (1917) suggests that the thorn scrub round Pietermaritzburg is regenerating after having been felled for firewood, and Sim (1907, p. 49) gives historical evidence to show that Acacia has vanished over parts of the Transkei because of felling. Nevertheless, this cannot reasonably be extended to cover the whole Union because of the huge areas involved and the sparseness of the population in many parts of those affected, and even with the aid of the most modern machinery, scrub clearing is an arduous and costly undertaking. Were it otherwise, there is little doubt that the Addo bush and allied formations, which are close to the largest city in the eastern Cape, would have vanished long ago, and that the scrub encroachment which is now under discussion would never have become a problem. Moreover, it is taking place in parts which were never under intensive Bantu settlement, for example in the Albany district, which in the eighteenth century was sparsely occupied by a tribe of Hottentots (Hewitt, 1920, pp. 27–31). Except for marauding parties, it was not until 1779 that the Bantu crossed the Fish River (Tooke, 1905, p. 386), and their stay was short, for the "Zuurveld" (the Albany, Bathurst and Alexandria districts) was cleared of Natives in 1811 (Cory, 1920, p. 7).

In many parts of the sweetveld the scrub growth extends from the hillsides in conspicuous ribbons down the lengths of small watercourses. As the watercourses are often too shallow to give the slightest protection from woodcutters or fire, neither can be held responsible for clearing all the surroundings of scrub and leaving these vestiges. The only apparent reason for them is the better water supply and shelter from wind, and the only apparent reason for their absence in the grasslands is the relative lack of both these influences.

The indications are that there is no satisfactory explanation for the original destruction of the scrub. From this it follows that the concept of a scrub climax where scrub is now encroaching must for the time being be treated with reserve. Conflicting evidence is presented in the extension of the Keiskammahoek cemetery, which has been protected for 61 years (Jubb, 1945). Grazing is occasional and there is no burning or cutting of the grass, yet in spite of this scrub species do succeed in establishing themselves, although rarely, as those responsible for the upkeep of the cemetery unanimously maintain. I have noticed (in 1950) one plant each of *Gymnosporia buxifolia* and *Acacia karroo*, in height three feet and one foot respectively. Both are growing in disturbed ground, apparently the sites of old termitaria which are broken down during the routine tidying of the cemetery. Kotsokoane (ms.) reports two additional seedlings of *Acacia karroo*.

2. It may be subclimax to grass. This means that it is lower in the succession than grass and hence more xeric, for the succession advances from xeric to mesic types of vegetation at Keiskammahoek with negligible exceptions. This possibility may be dismissed as extremely unlikely, for reasons already given.

3. It may be post-climax to grass, that is, it may have affinities with the forest. If so, it is more mesic than grass, and an intruder into grassland, which is under normal conditions too dry for it. Its present increase may be explained by the lack of grass competition (pages 28, 50).

4. It may originally have formed an open woodland, with grass between the trees. Possibly it is a misapplication of the law cited on page 121 which has caused among some ecologists a certain reluctance to accept the idea of a wide and stable community of trees and grass, and a tendency to seek as a reason for its presence a change in the original vegetation, caused by a changing climate or a disturbance by man or stock. For example, Bews (1916, p. 150) states that there are two views as to its origin: either the trees are "remants of a previously closer type of bush" or they are an "initial stage in bush succession". There does not, however, appear to be any reason why a climate should not be deficient in characters essential to the vigorous growth of grassland, and deficient at the same time in the ones essential to that of woodland, or why it should not be extensive and stable. Under the conditions described, the climate would be partly suitable for both, and trees and grass might be expected to grow together in a stable community, neither gaining the ascendency because a deficiency would prevent its becoming dominant. The term "tension belt" for a transition zone is perhaps an unfortunate one, for there is tension between the members of any community with the possible exception of those in deserts.

From the evidence as a whole, it is not possible to make a definite statement, but it is suggested tentatively that the odds are in favour of possibilities

3 and 4 (a scrub post-climax or an open woodland climax). There is not enough evidence at present to carry the argument past this point.

The Forests

A spreading of the forests has been reported from the high-rainfall regions of North America by Brown (1941) in an account of the vegetation of Roan Mountain, where the successional trends appear to be essentially similar to those of the Amatole mountains. The forests are interrupted by grassy spaces known as balds, which are coming under shrubby Rhododendron and Alder and changing finally to Spruce-Fir forest. Brown, giving several reasons for doing so, rejects the theory that they are Indian clearings, and states that the problem of bald origin is not yet solved. He considers that the present tree encroachment may be because of a change in climate. It is interesting that Rhododendrons should in North America play the same part as that played by the macchia at Keiskammahoek, for the Ericas which are such an important component of the macchia, and the Rhododendrons, are in the same family. Solereder (1898, pp. 481-2) reports that they also have the double leaf epidermis similar to that of *Erica brownleeae* and *Cliffortia linearifolia*. An excellent illustration of highland Rhododendron in North America is given by Macbride (1950, pp. 24–5).

Along the borders of the Keiskammahoek forests also, encroachment on the grasslands is steadily taking place. It is a mistake to regard the high forests as unstable communities barely able to reproduce themselves and liable to vanish unless left strictly alone. Their natural vigour is illustrated rather clearly at Cwencwe Forest Station, east of Evelyn Valley, by their encroachment on a grassy hilltop. In 1912, trig beacon 14 Cwencwe was established on this hill, and a recce report by J. B. Don, dated December of that year, states "... the beacon will be found in a corner of a grassy angle running into forest". Mr. H. A. Ruddock, of Trigsurvey, Kingwilliamstown, allowed me to extract the following note from his report on the beacon, dated 4th August 1946 and headed *Report on Tertiary Recce: Area* 32/27*MP*14 *Kingwilliamstown:—*

> "It is situated 42 feet inside the perimeter of an extensive indigenous forest, consisting of enormous trees probably well over 100 feet high . . . I managed by cutting undergrowth to make the secondary point 23 FRANKFORT and the proposed tertiary MPAHLANA visible. By extensive felling of large trees, the secondaries 92 WIESBADEN and 3 BALAZIE could possibly be made visible, but I do not think this is practicable. In my opinion, 14 CWENCWE is quite useless."

Unless one stumbled upon it by accident, one would be put to a great deal of trouble to find it, for although the lane cut in 1946 is still open, the gloom inside the forest is too deep to allow the beacon to be seen easily from outside. I visited it on 13th October 1950, and was fortunate in obtaining the help of the forest foreman at Cwencwe, Mr. W. R. Cloete, who was able to go straight to the spot. The distance between the beacon and the edge of the forest was approximately 27 feet, measured to the stems of the last mature trees. Mr. Ruddock has informed me that the discrepancy between this distance and that given in the recce report is probably a matter of interpretation. He may have taken into account the canopy or the seedling trees. The three secondary points mentioned in the report were already established when Don visited the beacon, and were presumably visible from it at that time.

Cliffortia linearifolia, *Cliffortia paucistaminea* and *Erica brownleeae* are all growing on this hill, but only sparsely, the grasses being everywhere dominant outside the forest. There is no screen of shrubs or bush on the forest margin, which is here abrupt and appears to be advancing directly on the grassland through scattered seedlings. In other parts (page 79) the encroachment is often through macchia.

Except in detail, the spread of the Keiskammahoek forests is taking place in the same way as that of the scrub, and with minor adjustments according to common sense the same arguments apply, namely that climatic change or uncontrolled grazing may be responsible for the spread, and that the forests are post-climax on many of the exposed situations where they are now encroaching. The theory, applicable to scrub, that they once formed an open woodland on these places is not acceptable, for unless they have been thinned artificially, forest trees do not form open woodland. The theoretical reason for this is probably best grasped by picturing a patch of forest in a central favourable habitat, surrounded by concentric zones where conditions are progressively less favourable. It is suggested that where the zones tend towards heat and aridity, the forest gives way to thorny scrub, and it is this that forms a parkland before the pure grasslands are reached. Similarly where the zones tend towards high winds and cold the forest gives way to macchia, which forms a parkland giving way to grasslands. There is an example of a macchia parkland on the farm Fort Merriman, on the road between Stutterheim and Keiskammahoek, and near the boundary between the two districts. It is made up of widely-scattered trees of *Protea multibracteata* (photograph 85).

CONCLUSIONS

Macchia is apparently the climax above the forests and between them, with grasslands on the most exposed parts. Its encroachment is normal and it is doubtful whether any system of grazing will stop it. Its regrowth will continually have to be checked by fire or by mechanical clearing.

The scrub is probably post-climax where it is now encroaching. The significance of this is that if these areas are protected from uncontrolled grazing, they should remain grassland with sound grazing systems alone, and without artificial aids.

CHAPTER 5

ECONOMIC BOTANY AND POINTS OF GENERAL INTEREST

LAND USE

GENERAL

Houghton's studies in the Keiskammahoek district (in press) have led him to conclude that "the only means of survival of the present population is for some members of the households to seek to earn a livelihood outside the reserve and to support those remaining behind by remittances". That under present conditions the land is carrying more people than it should is shown also by the devastation in the mountain and lowland pastures, the new areas of cultivation appearing on progressively steeper slopes and the shrinking of the unprotected forest patches because of damage by stock and woodcutters.

It is generally accepted that good methods of land use can greatly increase production, among these methods being controlled grazing, scrub clearing, irrigation, the use of fertilisers and weed-killers, and the bringing of more land under cultivation by means of contour banks and terraces, and there is no doubt that the district could support more people than it does, and support them without the deterioration of soil and vegetation that is at present going on. This, however, may not be the complete solution to the problem. History shows that there has been a very large increase in the population during the last hundred years (page 146), and although one cannot with certainty predict a like increase in the future, the possibility is one that should not be summarily dismissed. For this reason, any plan for restoring and maintaining the productivity of the vegetation and the land in the district should take into account the difficulties which will inevitably occur if there should be increasingly heavy demands made upon them. The disastrous consequences of ignoring the rise of population in the past are mentioned on pages 145–8. It would seem most unwise to repeat that mistake. While it is not suggested that planning should be extended to cover the remote future, it does nevertheless seem advisable that planners should look a great deal further ahead than has in the past been thought necessary, and that the potential length of time before mankind should not be entirely lost sight of. Wells, Huxley and Wells (undated, p. 274) and Jeans (1948, p. 134) have some interesting remarks to make on the last subject.

SWEETVELD

In the sweetveld as a whole, there is little erosion that calls for large-scale conservation engineering, what donga erosion there is being small enough to be dealt with by hand. Such methods include checking the flow of water by barriers of stones packed according to the method used by Pentz in parts of the Drakensberg Reclamation Area, establishing vegetation across the beds of dongas, for which purpose American aloe is outstanding, and protecting eroded areas from grazing during the time they are recovering. The details of all these methods are known to the officials of the Native Affairs Department, and advice, if needed for more comprehensive schemes, could be obtained from the Extension Officer at Kingwilliamstown, and from engineers in the Government service. For these reasons, it is felt that a full discussion is unnecessary in this paper.

Less spectacular, but with more serious consequences, it is sheet erosion which does most damage at Keiskammahoek, and until the grazing can be controlled there is little that can be done to stop it. Resting, followed by controlled grazing, is all that is necessary to bring back the cover, for the local veld has a marvellous capacity for recovering after ill-treatment even when the top-soil is gone. This is also well known to the municipality and the Government officials, who have obtained striking results in reclamation in various badly-denuded parts in the sweetveld.

Considerable parts of the river round the town have straightened their course and become wider since the old picture postcards were printed in 1912. This process is faster than it should be along most of the rivers in the lowlands and could be greatly slowed down if grazing and cultivation were prohibited within even as little as 20 yards from the water's edge. Such protection would put a stop to the breaking away of the soil from trampling and ploughing, and the resulting margin of vegetation would check the eroding action of the water when the rivers were in flood. These benefits are recognised in Mauritius, where a law requires that every stream shall be guarded by a strip of undisturbed vegetation (Schonken, 1930, p. 211). Locally, there would no doubt be legal difficulties in the application of the scheme, and compensation to be paid to the riparian owners.

There are about 30 square miles of comparatively valueless thorny scrub in the lowlands that could be eradicated to make way for pastures with a higher carrying capacity, the results that may be obtained by this means having been clearly shown by Mr. E. D. Matthews on the farm Tukulu, near Alice. The first necessity, however, is fencing, for strict grazing control is necessary after clearing, particularly where the scrub is dense and the grass cover consequently thin. Great harm may be done by removing even noxious vegetation if heavy grazing permits nothing to take its place, and it is suggested that until the cover is normal again, grazing should be done in the winter only, to allow seeding to take place unhindered. The difficulties of scrub clearance are likely to be lessened in the near future by the development of the new and promising chemicals which are at present in the experimental stage. Reseeding of the veld by hand is not recommended at present, for there are no areas of sweetveld in the district or in its neighbourhood which could provide more than a very meagre supply of seed, nor is there sufficient information about the germination of the local grasses to warrant its application on a large scale. The labour involved in planting grass roots and the uncertainty of the results make this method out of the question as well, except where urgently needed to stop erosion. Subdivision, controlled grazing and adequate watering-places for stock are essentials too well known to call for discussion.

Apart from relatively small areas, the sweetveld is not generally suitable for agriculture by reason of the heat, the low rainfall and the rugged topography, and it is thus important that advantage should be taken of every favourable influence. The possibilities for irrigation need to be explored, and it seems advisable also that attention should be paid to the aspect of cultivated lands, for the dry type of vegetation which grows on the northern slopes is everywhere in contrast to the moister type on those facing south. Although examples may be seen alike in the most advanced and the most primitive stages in the succession, whether in the highlands or the lowlands (photographs 38, 81, 82), this fixed rule has found little application in the agriculture of the district, arable lands, even where the owners have a choice in the matter, being located nearly always for convenience in ploughing, and in disregard for the effects of the climate. I have found no published figures correlating yields with the aspect, but from the examples occurring in the natural vegetation, it would appear to be a sound recommendation that arable lands should be located on the south slopes wherever possible.

The high rainfall in the sourveld is apt to give a wrong impression of fertility and general suitability for agriculture, but the climate is in many respects unfavourable to plant growth, as has been pointed out in chapter 4, and the highland soils are in addition generally poor and acid (Scott, 1949, pp. 14, 62). Moreover, because of the importance of the highlands as a catchment area, and their steepness, it is not advisable to allow cultivation there until the people are much further advanced agriculturally than they are at present. There appears no objection, however, to the utilisation of the highlands as a grazing area, provided it is done under supervision, and subject to certain provisions which are to be mentioned.

There are about seven square miles of Helichrysum in the sourveld and more macchia that could be converted to grass and brought under controlled grazing, and these pastures could play a most important part in the maintenance of the stock because of their potentially heavy yields. As they afford poor winter grazing, they could be used to the best advantage by being grazed in summer. It is unlikely that they will ever contribute much of value towards winter feeding because the topography prevents the use of the mower except on the Wolf plateau and a few smaller areas, and there are thus not many possibilities for making veld hay.

As over much of the highlands the protection afforded by Helichrysum and macchia prevents both donga erosion and sheet erosion from becoming serious, it is in localised areas rather than on the highlands as a whole that damage is taking place. The firebreaks round the forests for example are regularly cleared of vegetation, and at present there appears to be no alternative to this unfortunate necessity. In many parts of the Chatha firebreaks, and on those near Mount Thomas, erosion is becoming a serious matter. It is suggested that rough contour banks, such as could be made and maintained by unskilled labour, might be a cheap method of halting a great deal of the harm.

Photograph 80 shows the damage that can be done by the practice of dragging timber from the plantations to the loading point. Where the slopes are steep and the danger greatest, trouble could probably often be avoided by rigging a cableway for the purpose. Sleighs cause similar damage wherever they are used, and attempts should be made to discourage the use of them and to obtain the co-operation of the people in this matter.

Tunnel erosion, which has been dealt with in a paper by Henkel, Bayer and Coutts (1938) and appears difficult to cure, is occasional in the Helichrysum areas. The extensive surface erosion occurring in the Mnyameni Valley, and caused by heavy trampling, has been mentioned on page 114.

Some of the most vulnerable areas, although they are at present under grass, are the lands above Chatha Forest Station. They are very steep (slopes of more than 32 degrees have been recorded) and their soils, being peaty, are not only easily washed away but are also susceptible to wind erosion (Bosazza, 1950). This is one of the steepest and hence least accessible parts of the district, and has so far escaped destruction. Photograph 67 shows that hungry cattle are agile enough to reach almost every part of these mountains, and it is recommended that the north-eastern corner of the Chatha ministerial grazing be closed to stock except only in times of emergency. The rest of the Chatha ministerial grazing should be sub-divided and the movement of stock strictly controlled. This is obviously true of all the pastures in the district, but it is emphasised here because of the shallowness of the soil, the steepness of the slopes and the importance of this particular part as a catchment area, the source of the Chatha River. It should have priority in fencing materials, and a very close watch must be kept upon the grass cover. Next in importance are the upper reaches of the Mnyameni Valley and the land north of Dontsa Forest Station, also considerable catchment areas and heavily stocked.

A beginning has already been made with the fencing of the seepage areas where the mountain streams have their source. This work is doubly necessary, firstly because the seepage areas bear a different vegetation from their surroundings, and because it is one of the principles of controlled grazing that fencing should be done according to the vegetation. Secondly, cattle have the habit of loitering in and around them during hot weather, with consequent damage to soil and vegetation (see photograph 79).

The extensive areas under macchia, and their importance in protecting the sources of the Amatole streams, make it necessary to consider carefully any points for and against it before any schemes are undertaken to destroy it and establish grass in its place.

The widely-held view that shrubs and trees cause a greater precipitation on the area they cover than would otherwise occur has been discredited by the investigations of Fourcade (1942). It is hence doubtful if a cover of macchia has any advantage over one of grass in the maintenance of a steady flow of water in the catchment areas. In the matter of soil protection also, there is little to choose between them (see page 84).

Thus for soil and water conservation, which, as Professor Robb has often pointed out, is the primary function of vegetation, the two formations are of approximately equal value. It is in the secondary function, the providing of fodder, that the grasslands are incomparably more valuable. "One plant family, the grasses, is of greater importance to man than all the other approximately three hundred families of flowering plants put together" (Hitchcock, 1929, p. 133). At Keiskammahoek, however, there are under present conditions practical objections to the grasses, for grassland means grazing, grazing without control means erosion and ruined land, and control is impossible without fencing material and the co-operation of the people. Where grazing cannot be controlled, macchia has a decided advantage in that it affords with time an increasingly effective barrier to stock, and catchment areas are safe from damage in all places where the community has become mature. From the practical point of view it has one serious defect, for as soon as the community approaches maturity it is threatened by the constant possibility of fire, and when an area of dense macchia has been burnt the ground remains bare much longer than it does after a grass fire.

In spite of the disadvantages of macchia, the abuse of grassland constitutes so serious a menance to the people of the district and to others who are dependent upon the Amatole water, that it is recommended that attempts should not be made to bring macchia areas under grass unless there are facilities for the strict control of grazing. It should be borne in mind also that although there is no doubt of ultimate success except where there is heavy infestation with Rubus (photographs 48–51), the conversion is a long and tedious process where the macchia is dense. The best method in densely overgrown areas would probably be to burn parts along the contours in rotation, season by season. This would ensure that the run-off would be checked by strips of vegetation instead of being allowed to rush unhindered down the slope, and that the fire would be kept to manageable proportions between the firebreaks. To obviate the regeneration of macchia from seed washed down from communities above the burn, it would be necessary to burn the strips in descending order.

It is not possible to estimate with accuracy the number of times the rotation would have to be carried out before the grass became dominant, because the circumstances in each area are different. The ideal of clearing the macchia thoroughly and maintaining the grasslands by controlled grazing alone is unlikely to be attained. In the first place, as macchia appears to be the climax formation in the sourveld, it will tend to invade the grasslands whatever their treatment may be, and in the second, the highland macchia is not as palatable as the lowland macchia is (page 83), and the grasslands are bound to be damaged before it is eaten, particularly where Erica is concerned. The principle of the occasional use of fire must be accepted in any scheme which aims at the efficient use of the mountain vegetation in its secondary function of beef production as well as its primary one of soil and water conservation.

It has been mentioned (page 85) that one cannot burn dense macchia without leaving the soil practically bare of vegetation. Reseeding might with advantage be tried in such bare areas once the rest of the veld had recovered sufficiently to supply the necessary seed. Themeda becomes plentiful when Helichrysum is removed, and seed from reclaimed Helichrysum areas (which are usually less rugged) would be fairly easy to collect. Its germination is as a rule good (see page 116).

Introduced grasses have been tried in the sourveld by Dyer. Details of the trials are recorded in the files of the Botanical Survey Section, Grahamstown, and a summary is given in Dyer's paper of 1929. In September and October 1927, a square in the north-west corner of Schonland's plot, in area one acre, was thoroughly prepared by ploughing, harrowing and cross-ploughing. The following grasses were planted on 18th February 1928:—

Arrhenatherum elatius
Beckeropsis uniseta
Brachiaria ? mutica
Bromus catharticus
Cenchrus ciliaris
Chloris gayana
Dactylis glomerata
Digitaria eriantha
Digitaria smutsii
Echinochloa pyramidalis
Festuca elatior
Panicum maximum
Pennisetum purpureum
? Phalaris tuberosa
Setaria aurea.

Some showed promise, but the Arrhenatherum, Bromus, Dactylis, Festuca and Phalaris were failures and were replanted on 18th and 19th of February 1930. As there was no vestige of any of them in 1947, it may be concluded that it would be unwise to try converting macchia areas to artificial pastures without comprehensive trials beforehand.

The land under Rubus and Stoebe is extensive enough to justify an investigation into methods of dealing with these two pests. At present no satisfactory method of control is known.

THE MINISTERIAL GRAZING

The ministerial grazing is ground which belongs to the Department of Forestry and is leased to the Natives for grazing on the understanding that this is a privilege and not a right. The total area is about 5600 morgen.

There are a little over 8000 cattle in the district, which number would appear inadequate to the needs of the 17,000 people. As the grazing grounds which the Natives possess are under present conditions insufficient to support even this inadequacy, the ministerial grazing is of the utmost importance to them. Its history may be pieced together from the correspondence and reports in the files of the Department of Forestry, Kingwilliamstown, and dates from 1853, when the Gaikas having been expelled from what is now the Keiskammahoek district, other Natives were settled in the area by Sir George Grey. The newcomers were people who could be depended upon not to take up arms against the colonists and were probably chosen to act as a buffer between them and the Natives of less predictable behaviour further to the east. Mr. A. E. Jubb, formerly Magistrate at Keiskammahoek, has stated to me in a personal letter "Various portions of the district were surveyed into 10, 20 and 40 acre lots, and granted to individual Natives in terms of a British Kaffrarian Ordinance and subsequently under Cape Law Tenure acts, either in freehold or quitrent tenure, and ample and adequate areas provided for grazing." There was plenty for everybody, and commissions visiting the district between 1882 and 1888 reported that "ample provision has been made for all requirements of the people both for agricultural and grazing purposes". It cannot be said whether the members of these commissions ignored the difficulties which the coming generation would have to face. Probably the abundance of land and the sparse population blinded them to what was coming. Conditions then and now may be judged from the following extract from a report by Dr. A. W. Burton (1950). The reference is to farms in British Kaffraria, which according to Hall (1856) was the country bounded by the Keiskamma, the Kei and the Klipplaat Rivers. "At the second sale in 1879, 71 farms whose total extent was 57,262 morgen realised the low sum of £2819. The largest of the farms—2054 morgen—was sold for £30. One buyer secured eight farms whose total extent was 5687 morgen for the paltry sum of £252." The price of land in those areas today, as indicated by advertisements in *The Farmer's Weekly*, is somewhere in the neighbourhood of £20 a morgen, and the census figures from Dr. Burton's paper show that the population of all races has risen from 64,212 in 1859 to 185,652 in 1946.

With respect to Keiskammahoek, Mr. Jubb's letter continues "No one reckoned on the natural increase of population, the unreliability of the chiefs of the various sections, who allowed more people to come in from adjacent districts and settled them on the commonage, or the fact that beacons (and fences) are anathema to the Native; with the result that the grazing areas are today in some, if not all, locations reduced to an enormous extent. You will find that locations like Wolf River, Rabula and Lenye have practically no grazing areas today because of squatters. When Mr. E. D. Beale demarcated the locations in about 1924, he found that there were no less than 2400 squatters on the commonage".

Only in 1909 was an agreement drawn up regarding the grazing on crown land. It is probable that this took place when the destruction of the grazing grounds had made it abundantly clear that something would have to be done. The date marks also the stirring of public opinion on the matter, as is shown by a minute, dated 2nd March 1935, in the Department of Forestry files referred to: "Eminent ecologists, irrigation engineers, the Botanical Survey Committee, forest officials, magistrates, individual farmers' associations and farmers' congresses and others have from time to time during the past twenty-five years drawn attention to the state of the veld and of the forests on these mountains resulting directly from overgrazing and trespass and bad methods of cultivation". A leader in the *Daily Dispatch* of 23rd August 1927 mentions that there was anxiety about the grazing 20 years earlier (1907).

If the public noticed the damage in 1909 or thereabouts, it is reasonably certain that deterioration had already been in progress for a number of years; and the abundance reported before 1890 together with the adverse reports after 1910 point to the beginning of the century as the likely turning-point in the composition of the veld.

The idea of the agreement of 1909 was a sound one, but the number of flaws became increasingly apparent as time went on. Many of the clauses were not observed and could not be enforced, with the result that the Natives gradually began to regard as their right not only certain privileges but also things which they had undertaken not to do. There was in addition doubt whether the headmen consenting to some of the agreements in the name of the people had been legally empowered to do so, and doubt whether they had signed in accordance with what the people wished. It was contended too that the implications of the agreements had not been fully understood at the time of signing. Although some of the arguments may have been specious, the contents of the files satisfy one that in general the Natives were sincere in their conviction that their inalienable rights were being encroached upon when the State began to do what it was entitled to do in terms of the agreement, and to fence in land for protection or for establishing plantations.

That the Government was in a legally unassailable position did nothing to ease matters, and the bitter resentment of the Natives may be judged from the fact that two lost their lives when they were involved in a fracas with Government employees who were carrying out their duty in enforcing some of the regulations. The grazing fees were twice allowed to get into arrear, and what looked like serious trouble was averted only through the tact of the officials most closely concerned.

A further cause of resentment arose from the fact that some of the beacons had in the course of time become lost or obliterated, so that areas had to be demarcated again, at times with a good deal of uncertainty.

The broad picture is an unhappy one of a diffuse policy in the beginning with the inevitable attendant difficulties in the shape of endless bickerings and compromises. An agreement was reached in 1938 whereby the South African Native Trust undertook to pay the ministerial grazing fees on condition that it should have control over the grazing system to be followed. The following extract from the Keiskammahoek District Record Book is of interest in this connection:—

> "On the 26th of April 1939, the Chief Native Commissioner advised that an arrangement on the following lines had been concluded with the Director of Forestry:—
>
> > 1. That the ministerial grazing leases in this district should be taken over by the Trust, the Trust to pay the yearly rentals at present rates as well as arrear rentals.
> > 2. The Trust to fence along the perimeter of the grazing areas and to sub-divide, likewise by fencing, the areas into suitable rotational grazing paddocks.
> > 3. The Chief Native Commissioner, in consultation with the Conservator of Forests, King William's Town, to limit the number of cattle to be depastured from time to time in the various grazing areas.
> > 4. As its contribution towards the cost of such fencing the Forestry Department will supply the Trust with the necessary fencing poles, free of charge. In the event of termination of the arrangement all material in the fence except the poles will remain the property of the Trust.
> > 5. In carrying out the fencing, small areas of forest land will, where practicable, be cut into the grazing camps so as to provide the necessary shelter for the cattle in winter. Similarly, small compensating areas of grassland will be cut into the forests and utilised as reserves for the growing of thatch, for which there is a great demand on the part of local Natives.
> > 6. No further land in these grazing areas will be withdrawn from pasturage and utilised for afforestation.
> > 7. Leases will be on a yearly basis as at present and arrangements will be subject to termination on six months' notice on either side, subject, however, to the consent of the Native communities who at present hold these leases.
>
> During January 1939 the Native Commissioner held meetings with the Natives, who agreed to the proposals, and the following agreement was signed by the headmen respectively and a number of their councillors:—
>
> > 'We, the undersigned, being duly authorised thereto by the residents of the .... location in the district of Keiskama Hoek,

do hereby agree that the grazing area known as the .... Ministerial Grazing Area be taken over and controlled by the South African Native Trust, hereinafter referred to as the Trust, on the following terms and conditions:—

1. That the Trust will pay the prescribed grazing fee to the Forest Department.
2. That the Trust will fence the grazing area, thereby also fencing off patches of forest and creating thatch reserves and that, where convenient, small portions of forest be cut into the grazing area as shelter for stock.
3. That the Trust be empowered to conduct rotational grazing and when necessary to limit the number of stock on the grazing area, and to close one or more of the fenced paddocks to allow the grass to seed, or for the purpose of combating Helichrysum.
4. That the grazing area be sub-divided into fenced paddocks, and as far as possible each with its own water supply.
5. That no goats be allowed on the grazing area.
6. That the Native Commissioner or his deputy be empowered to impound any stock found on the grazing area in contravention of paragraphs 3 or 5 hereof.
7. That the burning of grass will be prohibited except with the permission of the Native Commissioner.'

NOTE: As the result of overstocking in the past, the entire area of the ministerial grazing leases is badly affected with Helichrysum and 'Fynbos' and is now scarcely worth anything as a grazing area. Endeavours have been made to persuade the Natives to voluntarily eradicate Fynbos in order to permit recovery of grass, but with little success; the Gwili Gwili people have risen to the occasion and done what was required of them; the Mtwaku people did perfunctory work in the Mount Thomas camp only; people of the other locations have been promising to follow the lead of Gwili Gwili but have not as yet done anything."

PLANTS OF ECONOMIC IMPORTANCE

The native timbers are described so adequately by Sim (1907) that no additional notes are necessary in a general report of this nature. In the Crown forests at present, only dead or moribund trees may be felled and for this reason the forests fall into the category of what Sir John Russell (1949) terms "unused land", a misnomer, for they are being used, and that to the best possible effect—as a protection for the catchment areas. Both from the materialistic and the aesthetic point of view, no amount of money would compensate for their destruction. The trade in timber at Keiskammahoek is done mostly by the coloured people, who buy the trees from the Forestry Department and do the felling by hand. Unseasoned planks are sold locally, *Olea laurifolia* and *Podocarpus* spp. being the species most in demand.

Medicinal plants and fodder trees are disregarded in this paper for they have been dealt with by Watt and Breyer-Brandwijk (1932) and Dyer (1937) respectively. Those plants showing possibilities as garden flowers and ornamental trees are also disregarded. The subject is too large to be attempted here.

Sim (1894) lists just under 2500 species of plants in Kaffraria, and the uses to which they could be put are almost completely unexplored.

The list which follows contains notes on those few about which there is at present some information, and includes also the poisonous plants which have been observed. Detailed information on a few of these poisonous plants is given by Curson (c. 1926), and fuller information on nearly all of them by Steyn (1934). They do not appear to cause many losses in the district in spite of the abundance of some. The plants of minor importance, both useful and harmful, have not been dealt with. Many that bear wild fruits fall into this category, the fruits being in the strict sense of the word edible but of little use except as novelties.

Acacia karroo. Its uses have ben enumerated in Chapter 2.

Acokanthera spp. Poisonous. It is uncertain whether two species are involved, or two forms of the same species. They have been recorded from woodland types 4, 5 and 6, and are plentiful in the forest patches along the waggon track running southwards to the plateau above Debe Nek.

Aloe arborescens. Often used to make a strong and quick-growing hedge (photograph 84). An effective barrier to stock and at the same time excellent as a windbreak. Plentiful round the lower forest margins.

Aloe ferox. Yields the drug "Cape Aloes". Schauder (1949, p. 99) states that the demand for it is unsatisfied, and that the price to producers is at present about sixpence a pound. Notes on its collection and preparation, and references to the literature on it, are given by Reynolds (1950, pp. 466–8). *Aloe ferox* is, however, not common in the district. It occurs mostly near Fort Cox.

Amanita muscaria. Used as a fly poison and as a narcotic (Marloth, 1913, Vol. I, p. 23). Occasional in all pine plantations.

Amaranthus paniculatus. Widely used by Natives as a green vegetable, and particularly valuable as an anti-scorbutic. According to the *Flora Capensis* it is "cultivated in many warm countries for its grain. In India it supplies the staple food of hill tribes over a large area".

Asclepias fruticosa and *Asclepias physocarpa*. Poisonous. Widely scattered.

Asparagus spp. The young shoots of several species are edible. Widespread.

Aster filifolius. Poisonous in some areas, in others regarded as a useful fodder bush. Plentiful in denuded parts near the lower margins of the sourveld.

Azima tetracantha. Taints milk. Common in woodland types 2 to 5.

Bobartia gracilis. Discussed on page 97.

Boophone disticha. Poisonous. Usually found round the upper limits of the sweetveld, but uncommon.

Calodendrum capense. Sim (1907, p. 154) reports that the seeds contain oil, but that they are too bitter to be edible. In woodland types 4, 5 and 6, occasional.

Cassine kraussiana. Poisonous. Described under *Cassine capensis* by Steyn (1934, p. 605). Recorded from woodland types 4 and 6.

Catha edulis. Narcotic (Davison, 1927, p. 339). Rare (page 152).

Chrysocoma tenuifolia. Poisonous, but not consistently so. In some parts it is considered a useful feed. It does not appear to affect cattle. Widely distributed.

Combretum salicifolium. The nectar contaminates honey by giving it a taint and an unpleasant smell. It is a stream-bank species found only in the sweetveld.

Commiphora caryaefolia. The wood is not durable but as the tree grows easily from truncheons it is used to make live fencing poles. Recorded from woodland types 3, 5 and 6, frequent where hot and dry, otherwise uncommon. Sim (1907, p. 159) considers that there are two species of Commiphora, the key characters being the number of leaflets to the leaf, but the work of Wild (1950, p. 120) suggests that the number of leaflets may depend on the rainfall.

Cotyledon orbiculata. Poisonous. Rare in the sourveld, fairly common in the scrub round Burnshill and Fort Cox.

Cymbopogon marginatus. The distribution is discussed on page 155. This grass was formerly included under a closely-allied species which is cultivated in the East for the production of citronella oil (Stapf, 1906).

Cynanchum sp. Probably poisonous. Occasional in woodland types 2, 4 and 5. Not recorded from 3, but likely to be present.

Cyperaceae. Various of the larger species are used by the Natives in the making of baskets and mats. Common on river banks.

Cyphia assimilis. Although not recorded as an edible species in the *Flora Capensis*, the tuber is nevertheless edible. It is very watery and rather tasteless. Occasional among grass in the sweetveld.

Datura stramonium. There is at present a demand for the seeds in Europe at 17s. a pound. It is not known if the demand is temporary or not. It is a common weed in cultivated lands.

Dovyalis tristis. The fruits may be eaten, and make a good jelly (Sim, 1907, p. 130). I am unable to distinguish between this species and *Dovyalis zeyheri*, which appears to be essentially similar except for its possession of spines, and which is occasional in woodland types 2 to 5. Spininess is an unreliable key character in most members of the family.

Equisetum ramosissimum. Poisonous. On stream banks, uncommon.

Euphorbia triangularis. The strong and light wood has potential uses, and the possibilities of exploiting this species are at present being investigated by an Italian firm. Widespread in patches below the forests.

Festuca costata. Recognised as a very good thatching grass. In the Fort Beaufort district a rondavel thatched with it was demolished after 30 years. The grass was still in perfect condition. Thatching grass at present fetches £8 a thousand bundles 4 inches by 5 feet. Festuca occurs abundantly but in patches near the tops of the mountains (see photograph 76).

Ficus sp. The bark is used for rope. Woodland types 5 and 6, uncommon.

Gramineae. Several species may contain dangerous amounts of hydrocyanic acid when wilted. Cynodon in particular has been known to cause heavy losses in the Fort Beaufort district.

Hyparrhenia buchananii. Makes a brown paper of good strength and quality, and, with bleaching, a fairly good cream-coloured or white paper (Stent, 1924, p. 251). It is much used for thatch. The distribution is given on page 154.

Matricaria nigellaefolia. Poisonous. Occasional in the mud at the edges of ponds and sluggish streams.

Melianthus major. Poisonous. Occasional in wet places on forest margins.

Nasturtium officinale. Used as a salad. Fairly common in shallow running water in the sweetveld, and recorded also from the highlands.

Olea africana. One of the commonest trees in the heavy dolerite soils, being particularly plentiful in the neighbourhood of the Boma Pass. While its fruits are of no economic value, the tree is of importance for two reasons. In the first place it may be an indicator of suitable conditions for the European olive, which is closely related, and in form and foliage hardly to be distinguished from it. In the second, the wild species may be used as a stock for the cultivated one, as has been successfully demonstrated by Italian prisoners of war on several farms in the Union. There is an article by MacOwan (1897) on olive culture at the Cape. It contains useful information, and the following is a brief summary of the important points in it: Olives cannot be planted and left to fend for themselves, but require a certain amount of care and cultivation. The minimum spacing is 20 feet. The seed needs special treatment before it will germinate, and it germinates erractically and gives rise to a proportion of off-type trees. For these reasons, cuttings or truncheons give the best results. The trees come into bearing about the seventh year. The fruit is picked by hand and the oil may be extracted by a simple home-made apparatus. Hendler (1949, p. 93) states that there is also a factory at Paarl which undertakes the processing of the fruits, and that the demand for oil and pickled olives is practically unlimited.

Ornithogalum thyrsoides. The flowers sell well overseas. Some idea of the prices is given by advertisements in the Press, in which South African firms undertake to deliver the flowers in Britain at 10/6 for 50, 15/- for 100 and 27/6 for 200. The distribution of Ornothogalum is given on page 106.

Pappea capensis. The fruits are used for jelly, and also, according to Sim (1907, p. 171) for vinegar, oil and an alcoholic drink. Common in types 2 and 3.

Paspalum scrobiculatum. The grain is used as a staple article of food by the poorer people in all parts of India, but some varieties are poisonous and have been known to cause serious illness (Ayyar and Narayanaswamy, 1949). Scattered throughout the sourveld at Keiskammahoek, especially in disturbed areas near the transition to sweetveld.

Psalliota spp. Edible. Occasional in the sweetveld after rain.

Pterocelastrus tricuspidatus. A glue made from the roots is used in fitting wooden handles to iron implements (Liebenberg ms.). Woodland types 4, 5 and 6, fairly common.

Ricinus communis. The seeds contain about 32 per cent of an oil which is used in the manufacture of soap and paint. The producer could expect about 2/- a bushel for the capsules. A naturalised weed along roads and river banks and on old lands.

Rubus spp. The fruits may be eaten raw or made into jam. Common in parts of the sourveld.

Sansevieria grandis. Yields a good fibre and has been imported into Cuba for cultivation. The variety *zuluensis* occurs naturally in type 5, but is not common. It would be easy to grow, for according to a note in *Kew Bulletin* (1893, p. 187) "Small pieces of the leaf of any Sansevieria will strike root and form plants".

Sansevieria thyrsiflora. Produces a fibre of fine quality for string and thread (Leighton, 1917a, 1917b), and may be worth cultivating. As one of the requirements for the manufacture of paper and string is a plentiful supply of good water, there are possibilities for a factory at Keiskammahoek, where these conditions are amply fulfilled. One was established many years ago in Grahamstown to extract fibre from this plant, but was not a success (Brown, 1915, p. 250). It is fairly common in woodland types 2 to 4.

Sarcostemma viminale. Sometimes eaten as a salad by the Natives. Common in woodland types 2 and 3, occasional in type 4.

Senecio retrorsus. A poisonous species which is becoming a serious pest in the district, particularly where the grazing is uncontrolled and heavy. It is commonest in the transition zone between the sweetveld and the sourveld, but extends also into the two veld types themselves. Other species of Senecio may be found in quantity in almost all the grasslands. They should be regarded as potential stock poisons until they have been proved harmless.

Solanum sodomaeum. Poisonous, but not mentioned by Steyn. Dr. Adelaar of Onderstepoort reported in a personal letter that 400 gm. (about 14 oz.)of the green fruit given to a sheep caused acute hoven and death in a few hours. A smaller dose of 180 gm. (about 6 oz.) had no effect. The ripe fruits are much less toxic, and the leaves are probably harmless. This plant has almost certainly been responsible for losses among calves in the Alexandria district. It has a patchy distribution in disturbed places, mainly in the sweetveld.

Sutera atropurpurea. An infusion of the dried flowers, about a teaspoonful to a gallon of water, makes a fast yellow dye. Occasional in stony ground near Fort Cox and Burnshill.

FEATURES OF BOTANICAL AND BIOLOGICAL INTEREST

A few new records for the area were established, although the collection of the Keiskammahoek flora is still very incomplete; and some unusual plants, communities and habitats also deserve special mention.

Caesia eckloniana is found in patches in the Chatha ministerial grazing and on the lower slopes of the Hogsback near King's Nek, where it is fairly frequent. It has not previously been recorded east of Van Staadens, but Schonland (1927, p. 11) suspected that it grew in the district, and Miss L. L. Britten informs me that she has collected it near Grahamstown.

Catha edulis. There are about a dozen bushes on the outskirts of a forest patch (type 4) north of Gwili-gwili. No others have been found at Keiskammahoek.

Cliffortia eriocephalina occurs in isolated patches up to a quarter of an acre in size along the tops of the Amatole mountains. It has been seen also in the Kaga Berg 8 miles north of Bedford. Weimarck (1934, p. 45) gives the Uniondale district as its eastermost limit.

Cynodon dactylon. There is an unexplained relation between Acacia and Cynodon. It is not noticeable in the sweetveld, in which *Cynodon* spp. are now almost everywhere, but may be seen near the lower limits of the sourveld. It is that Acacia grows much more frequently in odd patches of Cynodon than in the normal sourveld sward surrounding them. As discarded grinding stones and traces of old huts show that the Cynodon patches mark disturbed areas, there are no grounds for assuming that the Acacia has by its presence killed the more advanced grasses; it appears rather that the Cynodon was there before the Acacia and presented more favourable conditions for it. Several such communities may be seen near Dontsa, and they have been noticed in the Albany district as well. Weeds also grow more readily and sometimes exclusively in these Cynodon patches. *Cynodon dactylon* forms a particularly dense mat, and has a root system which is both spreading and deep (Murray and Glover, 1935). It would not appear to offer less competition to invaders than the sourveld species, but it evidently does.

It should be noted that Meredith (1947, p. 171) reports that *Cynodon dactylon* is aggressive enough to keep out weeds, but that this is when it is well fertilised.

Debe Hollows. Below about 2500 feet, sourveld areas at Keiskammahoek are pitted with the curious hollows from which the Debe Flats have obtained their name, the Xhosa word being *indebe*, a cup or ladle. In the sweetveld they are not found, nor in the sourveld above about 2500 feet, and they are confined to a strip between the Amatole mountains and the sea, bounded roughly by Debe Nek, Evelyn Valley, Amalinda and the Nahoon River (Pickford, 1926). They are between three and four feet deep, irregular in shape and in area from one to about ten square yards, as shown in photographs 31 and 83, but near the limits of their distribution they are shallower and may sometimes be unnoticed except early and late in the day, when the sun is low enough to cast shadows across them. Examples like this occur near Dontsa. They are found in the forests as well, at least in the Debe Nek area, but the dense vegetation and the deep litter make them difficult to see. They are apparently unique in the Union, but I have seen similar hollows in the same type of veld in Kenya on the road between Nairobi and Eldoret.

Except where an intercommunicating series on a slope ensures good drainage, the sourveld grasses are absent from the bottoms of the hollows, the vegetation consisting instead of a mixture in which some of the following are usually represented:—

Alchemilla sp.
Andropogon appendiculatus
Agrostis lachnantha
Aponogeton spathaceus
Cyperaceae
Eragrostis plana
Sporobolus indicus
Trifolium sp.

There is also an ephemeral society of frogs and water-insects after rain.

Pickford has produced evidence that the giant earthworms (Microchaetus), which are abundant on the Debe Flats, are responsible for the formation of the hollows, for they tend to throw their castings in groups away from puddles and near solid objects like stones and the stems of trees, thus gradually working the earth into mounds. These earthworms are found also in parts where they do not make hollows. Pickford is of the opinion that the deciding influence in the formation of hollows is the level "hard pan" of ironstone gravel which underlies them and confines the earthworms to the superficial layer of soil.

The hollows have a marked influence on the soil moisture because of the way they hold water after rain (see photograph 31). It is interesting to note that it has been considered worth while in some parts of Canada to produce similar hollows artificially by means of a special implement known as a basin lister. The land so treated is allowed to lie idle every second year with a little cultivation to keep down weeds. Crops sown between these periods of rest thus have, in addition to the season's rain, an extra supply of water collected in the hollows the season before, and stored in the soil. By this method wheat is successfully grown without irrigation where there is a 12-inch rainfall. However, the parts in question have a winter rainfall, which coincides with the growing wheat crop, and temperatures are low and evaporation probably less than in South Africa.

Ordinary methods of cultivation soon produce an even surface in place of the former inequalities, so that the advantage of this most effective water storage system is lost, and a consequent detrimental effect on underground water supplies may logically be expected.

Dovyalis zeyheri. This bush sometimes has a subtle but nevertheless most offensive smell of carrion emanating from the leaves. The exact nature of the smell is puzzling, for it does not become stronger if one bruises the leaves, nor do they contaminate one's fingers. Sometimes the smell is absent. It is not known whether this is because of strain differences or whether it is seasonal.

Elytroppapus rhinocerotis is recorded from Kaffraria by Sim (1894, p. 47) but since it is still a rarity after 57 years, one may conclude that the environment is unsuited to it and that it is unlikely to become a nuisance in these parts. It is grazed in times of great scarcity. Only two specimens have been found at Keiskammahoek, one near Charybdis and the other on the mountains between Chatha and Dontsa Forest Stations.

Erythrina humeana. One bush is at present growing on the western foothills of Charybdis. The nearest other so far found is at Mnxesha.

Euryops spathaceus forms an isolated small community on the rocky hill overlooking the village from the east. As other species of the genus have become a pest in the Queenstown and Graaff-Reinet districts, it would be advisable to watch for any spread of these plants.

Fallow Lands. West of the golf course is a piece of level ground appearing at first sight to be rather heavily grazed virgin veld. From the neighbouring hills, however, which give a bird's-eye view of the land as a whole, and from the aerial photographs, old cultivation marks are clearly visible, and a careful inspection shows that the ploughing of former times gave rise to slight parallel ridges which have persisted to the present day. They are between 24 and 30 feet apart, and raised only a few inches above the general level of the fallow. The rise is perceptible for about 6 feet on either side of the centre line of the ridges. Among the grasses on them are more *Cynodon* and *Eragrostis* spp. than on the fallow as a whole, where Themeda predominates, and for this reason the ridges are fairly easily discernible. What makes them stand out more than their vegetation is the striking way in which the termitaria are concentrated along them. The figures, given in Table 36, indicate that in addition to being more numerous, the termitaria are also bigger on the ridges.

Dr. W. G. H. Coaton, of the Division of Entomology, has kindly given me two possibilities for this state of affairs. His letter reads as follows:—

> "The *Trinervitermes* spp. favour the better drained slopes as nesting sites rather than the flats. This can be seen very strikingly in the Koffiefontein area. In the second place, the swarming winged female imagos, when settling, always seek out a somewhat elevated surface to call the males to them. In a featureless locality, especially where there is no grass and bush cover to give elevation to the females, any raised mound, hump or ridge would naturally be used by the female in preference to flat soil surface. Once male and female meet, they dealate and dig into the soil in the immediate vicinity."

Hemitelia capensis. A few specimens grow in the Wolf Ridge forests. So far, no others have been seen. Outside the district they occur at Evelyn Valley.

TABLE 36

POSITION OF TERMITARIA ON FALLOWS

Ridges	*No. of Termitaria*	*Av. Ht. of Termitaria*	*Level Strips*	*No. of Termitaria*	*Av. Ht. of Termitaria*
1	43	1·13 ft.	1	42	1·00 ft.
2	52	1·02 ft.	2	27	0·83 ft.
3	58	1·15 ft.	3	40	1·08 ft.
4	47	1·00 ft.	4	29	0·70 ft.
5	61	0·96 ft.	5	32	1·00 ft.
	261			170	

Total area of ridges 6000 sq. yds.—termitaria per acre 210·5
Total area of level strips 12900 sq. yds.—termitaria per acre 63·8

Hyparrhenia buchananii. It has been mentioned on page 110 that this grass is characteristic not of the sweetveld or the sourveld but of the transition zone between them. It also shows a preference for the margins of roads, as may be seen between Keiskammahoek and Chatha Forest Station, and near Dontsa. This peculiarity is shown on a vast scale in Griqualand East and Natal, where there is often a dense and vigorous growth of the closely-allied *Hyparrhenia hirta* along the roads, and it appears to have its counterpart in other countries as well, for in Schimper's *Plant Geography* (1903, p. 597) there is a photograph of natural prairie near Lincoln, Nebraska, showing "in the foreground cart-tracks with Andropogon—their constant attendant". It is significant that Hyparrhenia was formerly included in the genus Andropogon.

Within the limits of its normal distribution, Hyparrhenia is a common pioneer where roads and tracks are abandoned, and in fact any denuded or scoured areas seem to present specially favourable conditions for its growth. Many examples from Keiskammahoek show this, and it is a matter of common knowledge in the Transvaal and Natal. It is therefore not surprising that Hyparrhenia is apt to be plentiful where there is heavy and uncontrolled grazing. This is apparent on the damaged hillside south of the Rabula bridge on the road between Keiskammahoek and Debe Nek, and is another relation which holds true over very large areas, for the dominance of Hyparrhenia in the Tall Grass Veld (see page 110) is likewise bound up with disturbance. Mr. Acocks has informed me that protected areas in this veld are under a mixture approximating in composition the Highland Sourveld, with only a small proportion of Hyparrhenia. When the other grasses are weakened by heavy grazing, the Hyparrhenia becomes in time completely dominant, remaining so as long as its competitors are suppressed.

It grows well on fallow lands and on rocky ridges in the Transvaal, and Mr. Acocks, in a personal letter, states that it will grow in areas with an annual rainfall of as little as 6 inches, but in such places always on rocky hills, where temperatures are more favourable and soil water more plentiful than in the area generally (see pages 36 and 104). Rose-Innes (1937) reports also that near Johannesburg it grows luxuriantly round water-holes and stream banks.

All these facts lead one to the conclusion that Hyparrhenia demands a good supply of soil water. Where streams and water-holes are concerned the wetter soil is obvious. It is less so in the other examples quoted, but the arguments in favour of their having a wetter soil have been discussed on pages 28, 32 and 104, and thus do not need to be repeated. There is support for this conclusion from America as well, for Clements (1934, p. 57) looks upon the Andropogons as post-climax to the low prairie, and (pages 42–3) mentions relict patches of them on sandhills—physiologically moist, as has been pointed out on page 105 of this paper. In private letters to me, Mr. R. Rose-Innes also has emphasised the importance of the Andropogons in North America along rivers, in moist valleys, in sand and on rocky hills.

The tribe to which Hyparrhenia belongs (*Andropogoneae*) is as a whole almost confined to the tropical and warm temperate regions (Hutchinson, 1934, p. 299), being particularly well represented, in species and numbers, in what Bews calls the High Grass Savannah, described (on pages 293–5) as "a broad belt surrounding the rain forest". He reports similar High Grass Savannah with Andropogons from Ceylon. Thus, according to Bews's description also, the Andropogons may be expected to be characteristic of fairly moist habitats. Yet in his work of 1929 (page 250) Bews states that Hyparrhenia is one of the most important genera in drier types of grassland, as well as in the moister High Grass Savannah. The explanation for its frequency both in wet and dry habitats may be that the dry habitats become moist enough to support it when competition from other grasses is eliminated, and accordingly the Andropogons in areas generally dry may be expected to grow well on landslides, in selectively grazed veld, on old roads and the like, and this is in fact what does happen. The abundance of Hyparrhenia along the Natal roadsides is probably due in some measure to the loose bare earth, the run-off from the roads, and the drainage ditches, which singly or in combination cause a localised increase in soil water. It is difficult, however, to account for the dominance of this grass on road margins even along the tops of cuttings. Either there are additional forces at work, or else the rain may seep horizontally inwards by capillarity from the exposed face of the cutting.

The points put forward may reconcile two conflicting statements by Bews (1916, p. 146)—one that the Andropogons are intermediate between Themeda grasslands and bush, and the other that Andropogons, on ground freshly laid bare, are ousted by Themeda. The explanation appears to be that they are ousted by Themeda *in dry areas*, where, being out of their true habitat, they can live only if the competition is slight.

A difficulty in the theory that Hyparrhenia is one of the more mesophytic grasses is that Bews (1916, p. 146) reports that *Aristida* spp. are found together with Hyparrhenia in denuded ground, and according to him (1929, p. 211) "all species of Aristida are xerophytic". It is suggested tentatively that the distribution of *Aristida junciformis* in the Natal mist belt (Acocks, in press) may invalidate Bews's use of the word *all*.

In the cooler areas, *Cymbopogon marginatus*, which also used to be included under Andropogon, often plays the same part as the Hyparrhenia below it. It grows in the moist areas round the forest margins and may become dominant almost to the exclusion of other grasses if the original mixed cover is damaged by uncontrolled grazing. Its dependence on adequate soil water is shown in many parts of the sourveld by its local dominance where boulders shed the rain on the surrounding ground, and along dongas and old roads.

The evidence as a whole seems to be that *Hyparrhenia buchananii*, *Hypar-*

rhenia hirta and *Cymbopogon marginatus* may have high water requirements, and that this may apply as well to numbers of their allies.

Although it is mentioned in the introduction, it is perhaps advisable to stress again that these observations are true in general rather than in detail. As Mr. Acocks has pointed out to me, one may find Andropogons and their allies in areas of low and high rainfall, from sea level to the mountain tops, in frosty, frost-free, sandy, stony or turfy habitats, and a consideration of the water-relations alone in naturally incomplete. Hyparrhenia, for example, has preferences also in the matter of soils and temperatures. It seems to favour the dolerite soils at Keiskammahoek, and the lower temperatures of the highlands may be the factor preventing its growth above the forests. Hartley (1950) has with good reason concluded that temperature is the most important factor influencing the distribution of the tribe.

Olinia spp. are recorded from Stutterheim and Albany, but as far as is known have not yet been found at Keiskammahoek.

Othonna amplexicaulis has been seen nowhere else but on a nearly inaccessible terrace on Geju Mountain. It was not known east of the Port Elizabeth district before.

Stiburus alopecuroides grows in some of the vleis of the Wolf Ridge plateau. It was not previously known to extend further south than Tembuland.

SUMMARY, CHECK-LIST, GLOSSARY AND REFERENCES

SUMMARY

The district forms the drainage basin of the Keiskamma River, the encircling mountains ranging in altitude from more than 6000 feet in the north to about 3000 in the south.

The main geological formations are dolerite and the Beaufort Series, which cover roughly 25 and 75 per cent of the area and give rise to clay and loam soils respectively.

Throughout the district, 70 per cent of the rain falls during the summer.

In general, there is a drop in the average temperature from the lowlands to the highlands. The difference is roughly 12°F.

Maximum temperatures are higher in the lowlands by about 15°F.

Minimum temperatures are higher in the lowlands by about 7°F.

The diurnal range of temperature increases from the highlands to the lowlands. It averages about 17 and 26°F respectively.

There is a great deal of evidence in support of the view that areas under thick Acacia scrub were once open grassland, and that thicket formation is hastened by the elimination of grass competition.

Acacia is unlikely to become a pest in the sourveld, or where the annual rainfall is below 15 inches. It does not normally grow where the absolute minimum temperature for July averages 20°F or less, nor, in the Border area, above an altitude of about 3500 feet.

A large tree in a normal season will produce about 20,000 seeds. They are dispersed by strong winds and (to an unknown extent) by cattle. Germination under laboratory conditions is usually about 90 per cent, but may be delayed for three and a half years at least, even when the seeds are kept continually moist. They will germinate even when green and soft, provided only that they are fully formed, and if they are kept dry they may remain viable for 57 years at least. The reason for the delay appears to lie only in the impervious seed coat.

About 24 per cent of the seed is infested with weevil and wasps, and in the field—unless the seeds are covered with earth—other insects, field-mice and dry spells combine to keep the germination of the remaining 76 per cent down to a little over 1 per cent. If the seeds are covered with earth, between 6 and 7 per cent germination may be expected. Of all seedlings, about 95 per cent will usually die. These figures indicate that over 2500 seeds may be produced for every seedling that becomes established.

Natural enemies have not in the past been able to do more than check temporarily the spread of the trees.

Fire will cause a sudden abundance of seedlings, but will lower rather than increase the final germination figures.

It has been confirmed that Acacia does not regenerate if cut through sufficiently low down.

It is difficult to kill the seedlings by burning after they have become about 14 inches high.

The mixed scrub or bush which occurs in areas with an annual rainfall of about 25 inches and below also tends to increase more rapidly with uncontrolled grazing. It produces little usable timber.

The forests require a rainfall of over 25 inches. As they have fewer thorny species than the drier woodland types, little regeneration takes place if they are heavily stocked, and their tendency is to disappear unless they are protected.

Acacia is the most important pioneer tree in the succession near the lower limits of the forest. Above the limit of Acacia, *Rapanea melanophloeos* is the commonest of many.

Trichocladus ellipticus is the commonest tree in the moister forests, making up nearly half of the total.

Macchia is found near the forests, where the rainfall is about 30 inches or over. Below 4000 feet it consists almost entirely of *Cliffortia linearifolia.* This species germinates freely in the field if the light is adequate to its needs, and appears to be a successional stage more advanced than the grassland, leading to forest. As it is eaten more from necessity than by preference, it invades the grasslands slowly if they are protected or heavily grazed, and more quickly if grazing is light and therefore selective. A hot fire will kill it. Regeneration after a mild fire may be from seed or coppice shoots, but not from suckers.

The macchia above 4000 feet consists mainly of *Cliffortia paucistaminea* or *Erica brownleeae* or a mixture of the two. The laboratory germination of these two species is about 40 and 23 per cent respectively. Erica produces about 24 times the amount of seed that Cliffortia produces. Seedlings of both become established in all but the deepest shade.

Cliffortia paucistaminea is eaten in times of scarcity, *Erica brownleeae* seldom even then.

The highland macchia accumulates in time a thick litter which completely covers the ground, and makes the community a very inflammable one. Although macchia is killed by a hot fire, enough seed escapes destruction to give rise to a dense new growth. *Cliffortia paucistaminea* can grow again from suckers or coppice shoots. Regeneration of *Erica brownleeae* may be from coppice shoots but not from suckers.

Grass cannot successfully compete with it and is almost absent where the bushes grow thickly. The evidence is that the highland macchia is not seral to forest or mixed bush except in sheltered places, and that it is the climax above the forests. The historical records of grass in former days, where macchia now grows, may be explained by the annual grass fires which used to take place.

Pines, wattles and gums grow easily in the macchia zone but the indigenous forest trees do not.

The grasslands are of two types—the sweetveld, palatable and nutritious in winter and occurring where the annual rainfall is about 25 inches and under, and the sourveld, of little value for grazing in the winter, and occurring where the annual rainfall is about 30 inches or more.

If woodland types 1—4 are cleared away, the sweetveld grasses will take their place. Sourveld grasses come in if types 5—7 are cleared.

Good sweetveld has a basal cover of about 8 per cent in a Themeda-dominant sward, and 14 per cent in a Digitaria-dominant one. Good sourveld averages about 11 per cent.

Counts show that the selective grazing of sweetveld at Keiskammahoek may increase the frequency of the poisonous *Ornithogalum thyrsoides* more than sixty times. Animals, however, avoid it and deaths caused by it are rare. Most mature plants produce over a thousand seeds at a time, of which the germination in the laboratory is over 90 per cent. The rate of establishment of seedlings in the field is not known.

In the sourveld, Themeda is low in the succession, the higher stages consisting of mixed communities of grasses together with many species of herbs. With increasing altitude the sourveld soils assume a peaty texture and are easily damaged by trampling and wind erosion. Bare areas in the sourveld are often covered with mats of *Helichrysum argyrophyllum*, which has been studied by Schonland (1927) and gives excellent protection to the soil.

The physiologically dry character of the mountain climate at times is reflected by the xerophytic character of many of the plants growing there, ericoid leaves, woolliness and sunken stomata being specially common. The dominant vegetation is macchia.

In the dry and hot lowlands the xerophytic characters are mostly spininess and succulence, and the dominant vegetation is scrub.

The forests favour sheltered positions in the moist and mild climate between the two. Grass tends to occupy the exposed positions throughout.

Where it is not interfered with, there is a tendency for all the woodland to encroach upon the grassland. Where macchia is concerned, the reason appears to be the increasing rarity of grass fires, but the reason in the scrub and forest zones is as yet obscure.

The conditions of plenty reported in the district during the last century, and the mounting destruction of the vegetation in this, make it plain that the problem of population increase is fundamental to any plans for rehabilitation.

In spite of the widespread destruction of the grass cover, there appears to be little need for elaborate reclamation works in the district. The eradication of useless plants, followed by controlled grazing, will quickly restore the veld.

Bush and Helichrysum in the sourveld may be eradicated by burning. In the sweetveld the available methods of scrub clearance are expensive and tedious. In both areas, it is recommended that no attempts should be made to clear the useless vegetation before there are facilities for the strict control of the grazing.

It will not be possible to maintain a grass sward in the highlands without the occasional use of fire.

LIST OF PLANTS AND ANIMALS MENTIONED, TOGETHER WITH WELL-KNOWN COMMON NAMES

PLANTS

Abutilon sonneratianum (Cav.) Sweet	
Acacia caffra Willd.	Katdoring
Acacia decurrens Willd.	Green Wattle
Acacia giraffae Burch.	Kameeldoring
Acacia hirtella E. Mey.	
Acacia inconflagrabilis Gerstner	
Acacia karroo Hayne	Mimosa
Acacia natalitia E. Mey.	
Acacia melanoxylon R. Br.	Blackwood
Acacia mollissima Willd.	Black Wattle
Acanthosicyos horrida Welw.	Naras
Acokanthera venenata (Thb.) G. Don	Bushman's Poison
Agrostis barbuligera Stapf	
Agrostis bergiana Trin.	
Agrostis lachnantha Nees	
Allophylus decipiens (Arn.) Radlk.	
Alloteropsis semialata Hitch.	
Aloe arborescens Mill.	
Aloe ferox Mill.	
Alternanthera repens Steud.	
Amanita muscaria (L.) Pers.	
Amaranthus paniculatis L.	Cockscomb
Andrachne ovalis Müll. Arg.	
Angraecum mystacidii Reichb. f.	
Andropogon appendiculatus Nees	
Anthospermum aethiopicum L.	
Anthospermum lanceolatum Thb.	
Anthoxanthum ecklonii Stapf	
Apodytes dimidiata E. Mey.	White Pear
Aponogeton spathaceum Hook. f.	
Argyrolobium speciosum E. & Z.	
Aristida bipartita Trin. & Rupr.	Steekgras
Aristida galpinii Stapf	
Aristida junciformis Trin. & Rupr.	
Aristea schizolaena Harv.	
Arrowsmithia styphelioides DC.	
Artemisia afra Jacq.	Wormwood
Asclepias fruticosa L.	Tontelbos
Asclepias physocarpa Schltr.	Tontelbos
Asparagus virgatus Bak.	
Asplenium bipinnatum (Forsk.) C. Chr.	
Aster bakerianus Burtt-Davy	
Aster filifolius Vent.	Draaibossie
Aster muricatus Less.	
Athanasia punctata (DC.) Harv.	
Athrixia phylicoides DC.	
Atriplex semibaccata R. Br.	Creeping Saltbush
Azima tetracantha Lam.	Naaibos

Barleria obtusa Nees	
Behnia reticulata Didrichs	
Berkheya decurrens (Thb.) Hutch. & Burtt-Davy	
Berkheya setifera DC.	
Bobartia gracilis Bak.	
Boophone disticha (L.f.) Herb.	Sore-eye Flower
Boscia albitrunca Gilg & Benedict	Witgatboom
Brachiaria serrata (Thb.) Stapf	
Brachylaena elliptica Less.	Bitterblaar
Brachypodium flexum Nees	
Bromus firmior Stapf	
Bromus speciosus Nees	
Bryum argenteum L.	
Buchenroedera multiflora E. & Z.	
Buddleja auriculata Benth.	
Buddleja dysophylla (Benth.) Phil.	
Buddleja salicifolia Jacq.	Bastard Olive
Buddleja salvifolia Lam.	Sagewood
Bulbine asphodeloides (L.) Roem. & Schultes	
Burchellia bubalina (L.f.) Sims	Wild Pomegranate
Caesia eckloniana Roem. & Schultes	
Calodendrum capense Thb.	Wild Chesnut
Calpurnia sylvatica E. Mey.	
Canthium ciliatum Sond.	Skaapdrolletjies
Canthium mundtianum Cham. & Schl.	Klip Els
Canthium obovatum Kl.	Kwar
Canthium ventosum (L.) Sp. Moore	Skaapdrolletjies
Capparis citrifolia Lam.	
Capparis rudatisii Gilg & Benedict	
Carex petitiana A. Rich.	
Carissa bispinosa (L.) Desf.	Num-num
Carissa haematocarpa DC.	
Cassine aethiopica Thb.	
Cassine crocea (Thb.) O.K.	Saffronwood
Cassine kraussiana Bernh.	
Cassine papillosa (Hochst.) O.K.	
Cassine sphaerophylla (E. & Z.) O.K.	
Cassine tetragona (Thb.) Loesen.	
Cassinopsis ilicifolia (Hochst.) O.K.	
Catha edulis Forsk.	Bushman's Tea
Celtis kraussiana Bernh.	White Stinkwood
Centella glabrata L.	
Ceratiosicyos ecklonii Nees	
Chaetacanthus setiger (Pers.) Lindl.	
Chaetacme aristata Planch.	
Cheilanthes hirta Sw.	
Chloris virgata Sw.	
Choristylis rhamnoides Harv.	
Chrysocoma tenuifolia Berg.	Bitter Karroo
Cineraria deltoidea Sond.	
Cineraria lyrata DC.	
Cissampelos torulosa E. Mey.	
Cissus cirrhosa Pers.	
Clausena inaequalis Benth.	Perdepis
Clematis brachiata Thb.	Traveller's Joy
Cliffortia eriocephalina Cham.	

Cliffortia linearifolia E. & Z.	
Cliffortia paucistaminea H. Weim.	
Cliffortia serpyllifolia Cham. & Schl.	
Cluytia affinis Sond.	
Cluytia katherinae Pax	
Cluytia pulchella L.	
Coccinia quinqueloba (Thb.) Cogn.	
Combretum salicifolium E. Mey.	Bush Willow
Commiphora caryaefolia Oliv.	Corkwood
Cotula hispida Harv.	
Cotyledon orbiculata L.	
Crabbea nana Nees	
Crassula muscosa L.	
Croton rivularis E. Mey.	
Cryptocarya woodii Engl.	
Cunonia capensis L.	Rooi Els
Curtisea faginea Ait.	Assegai
Cussonia paniculata E. & Z.	Klippersol
Cussonia spicata Thb.	Kippersol
Cycnium racemosum Benth.	
Cymbopogon marginatus (Steud.) Stapf	Lemon Grass
Cymbopogon plurinodis Stapf	Turpentine Grass
Cynodon dactylon (L.) Pers.	Kweek
Cyperus teneriffae Poir.	
Cyphia assimilis Sond.	Baru
Danthonia curva Nees	
Danthonia disticha Nees	Koperdraad
Datura stramonium L.	Stinkblaar
Desmodium scalpe (Comm.) DC.	
Diascia rigescens E. Mey.	
Diclis reptans Benth.	
Digitaria diagonalis Stapf	Finger Grass
Digitaria eriantha Steud.	Finger Grass
Dioscorea sylvatica Eckl.	
Dobrowskya scabra DC.	
Dovyalis lucida Sim	
Dovyalis tristis Sim	Wild Apricot
Dovyalis zeyheri Warb.	Wild Apricot
Dracaena hookeriana K. Koch	
Ehretia rigida (Thb.) Druce	Stamperwood
Ekebergia capensis Sparm.	Dog Plum
Elyonurus argenteus Nees	Suurpol
Elytropappus rhinocerotis (L.f.) Less.	Rhenosterbos
Embelia ruminata (E. Mey.) Mez	
Encephalartos altensteinii Lehm.	Kaffir Bread
Englerodaphne pilosa Burtt-Davy	
Entada natalenis Benth.	
Equisetum ramosissimum Desf.	
Eragrostis caesia Stapf	
Eragrostis capensis Trin.	
Eragrostis chalcantha Trin.	
Eragrostis plana Nees	
Erica alopecurus Harv.	
Erica brownleeae Bolus	
Erica caffrorum Bolus	
Erica calycina L.	

Erica floribunda Lodd.	
Erica rupicola Kl.	
Erythrina humeana Spreng.	Kaffirboom
Euclea undulata Thb.	Gwarri
Eugenia zeyheri Harv.	
Eulalia villosa (Thb.) Stapf	
Euphorbia bothae Lotsy & Godd.	Noors
Euphorbia epicyparissias E. Mey.	
Euphorbia kraussiana Bernh.	
Euphorbia obesa Hook. f.	
Euphorbia pentagona Haw.	
Euphorbia tetragona Haw.	Naboom
Euphorbia valida N.E. Br.	
Euryopus dyeri Hutch.	
Euryops spathaceus DC.	
Eustachys paspaloides (Vahl) Lanza & Matti	
Fagara capensis Thb.	Knobwood
Fagara davyi Verdoorn	Knobwood
Falkia repens L. f.	
Festuca caprina Nees var. *irrasa* Stapf	
Festuca costata Nees	
Festuca scabra Vahl	
Ficus capensis Thb.	Wild Fig
Ficus burtt-davyi Hutch.	Wild Fig
Galopina circaeoides Thb.	
Gamolepis chrysanthemoides DC.	
Gardenia neuberia E. & Z.	
Gardenia rothmannia L. f.	Candlewood
Gardenia thunbergia L. f.	
Gelonium africanum Müll. Arg.	
Geranium ornithopodum E. & Z.	
Gnidia rattrayi Moss	
Gnidia sericea L.	
Gomphrena globosa L.	
Grewia occidentalis L.	Four-corner
Gunnera perpensa L.	
Gymnosporia acuminata (L.) Szysz.	Sybas
Gymnosporia buxifolia (L.) Szysz.	Pendoring
Gymnosporia capitata Sim	
Gymnosporia deflexa Sprague	
Gymnosporia nemorosa (E. & Z.) Szysz.	
Gymnosporia peduncularis (Sond.) L. Bol.	
Gymnosporia polyacantha Szysz.	
Gymnosporia undata Szysz.	
Halleria lucida L.	Wild Fuchsia
Haplocarpha scaposa Harv.	
Harpechloa falx (L. f.) O. K.	
Harpephyllum caffrum Bernh.	Kaffir Plum
Hebenstreitia dentata L.	
Heeria mucronata Bernh.	
Helichrysum argyrophyllum DC.	Amatola Weed
Helichrysum fulgidum Willd.	Everlasting
Helichrysum nudifolium (L.) Less.	
Helichrysum petiolatum (L.) DC.	
Helichrysum rosum (Berg.) Less.	
Helichrysum splendidum (Thb.) Less.	

Helichrysum trilineatum DC.	
Helinus integrifolius (Lam.) O. K.	
Hemitelia capensis (L. f.) Klf.	Tree Fern
Heteromorpha arborescens Cham. & Schl.	
Heteropogon contortus (L.) Beauv.	
Hippobromus pauciflorus (L.) Radlk.	
Hydrocotyle asiatica (L.) Urb.	
Hyophila zeyheri (Hope) Jaeg.	
Hyparrhenia buchananii Stapf	
Hyparrhenia hirta (L.) Stapf	
Hypochoeris radicata L.	
Hypolepis sparsisora (Schrad.) Kuhn	
Hypoxis argentea Harv.	
Ilex mitis (L.) Radlk.	Water Tree
Indigofera hedyantha E. & Z.	
Jasminum angulare Vahl	Jasmine
Jasminum multipartitum Hochst.	Jasmine
Juncus lomatophyllus Spreng.	
Kiggelaria africana L.	Wild Peach
Koeleria cristata Pers.	
Lachnopylis floribunda (Benth.) C.A. Sm.	Vlier
Lasiocorys capensis Benth.	
Leonotis leonurus (L.) R. Br.	Wild Dagga
Lepidostephium denticulatum Oliv.	
Leucosidea sericea E. & Z.	
Leyssera gnaphaloides L.	
Lightfootia huttoni Sond.	
Lithops lesliei N.E. Br.	
Lobelia erinus L.	
Lycium oxycladum Miers	
Lycopodium clavatum L.	
Maerua racemulosa Gilg & Benedict	
Mariscus capensis (Steud.) Schrad.	
Matricaria nigellaefolia DC.	
Melianthus major L.	
Melothria punctata (Thb.) Cogn.	
Metalasia muricata (L.) Less.	
Microchloa caffra Nees	
Mimusops obovata Sond.	Red Milkwood
Miscanthidium capense (Nees) Stapf	Tambookie
Mohria caffrorum Desv.	
Muraltia macroceras DC.	
Myrsine africana L.	
Nasturtium officinale R. Br.	Water-cress
Nemesia melissaefolia Benth.	
Nerine alta Barker	
Nidorella auriculata DC.	
Nymania capensis (Thb.) Lindb.	Klapper
Ochna arborea Burch.	Cape Plane
Ochna atropurpurea DC.	
Ocotea bullata E. Mey.	Stinkwood
Oldenlandia amatymbica (Hochst.) O. K.	
Olea africana Mill.	Olive
Olea capensis L.	
Olea laurifolia Lam.	Black Ironwood
Oplismenus hirtellus (L.) Roem. & Schultes	

Ornithogalum lacteum Jacq.	Chinkeringchee
Ornithogalum subulatum Bak.	
Ornithogalum thyrsoides Jacq.	Chinkeringchee
Osyridicarpos natalensis DC.	
Osyris compressa DC.	Bergbas
Othonna amplexicaulis Thb.	
Panicum deustum Thb.	
Panicum ecklonii Nees	
Panicum maximum Jacq.	Buffalo Grass
Panicum perlaxum Stapf	
Pappea capensis E. & Z.	
Parkinsonia microphylla Torr.	
Passerina filiformis L.	
Passerina montana Thoday	Pakaan
Passerina vulgaris Thoday	
Pavetta capensis (Houtt.) Brem.	
Pavetta lanceolata Eckl.	Christmas Tree
Pelargonium reniforme Curt.	
Pellaea hastata (Thb.) Prantl	
Pellaea viridis (Forsk.) Prantl	
Pennisetum macrourum Trin.	
Pentaschistis juncifolia Stapf	
Peperomia reflexa (L. f.) Dietr.	
Peucedanum capense (Thb.) Sond.	
Phylica galpinii Pillans	
Phyllanthus verrucosus Thb.	
Pinus montana Mill.	
Pinus ponderosa Doug.	
Pinus sylvestris L.	
Pittosporum viridiflorum Sims	
Plectranthus calycinus Benth.	
Plectranthus fruticosus L'Her.	
Plectranthus krookii Gürke	
Plectranthus thunbergii Benth.	
Pleurostylia capensis Oliv.	
Plumbago capensis Thb.	
Poa binata Nees	
Podocarpus falcatus (Thb.) R. Br.	Bastard Yellow-wood
Podocarpus latifolius (Thb.) R. Br.	Real Yellow-wood
Polygala confusa MacOwan	
Polygala myrtifolia L.	
Polypodium polypodioides (L.) Hitch.	
Polyporus gilvus (Schw.) Fr.	
Polystachya ottoniana Reich. f.	
Polystichum adiantiforme (Forst.) J. Sm.	
Polystictus sanguineus (L.) Fr.	
Portulacaria afra Jacq.	Spekboom
Protea lacticolor Salisb.	Suikerbos
Protea macrophylla R. Br.	Suikerbos
Protea multibracteata Phil.	Suikerbos
Protorhus longifolia Engl.	
Psoralea pinnata L.	
Psychotria capensis (Eckl.) Vatke	
Ptaeroxylon obliquum (Thb.) Radlk.	Sneezewood
Pteridium aquilinum (L.) Kuhn	Bracken
Pterocelastrus tricuspidatus (Lam.) Sond.	Cherry-wood

Putterlickia pyracantha (L.) Endl.	
Pygeum africanum Hook. f.	Red Stinkwood
Randia rudis E. Mey.	
Rapanea melanophloeos (L.) Mez	Boekenhout
Relhania trinervis Thb.	
Rhamnus prinoides L'Her.	Blinkblaar
Rhigozum obovatum Burch.	
Rhoicissus capensis (Burm. f.) Planch.	Wild Grape
Rhoicissus cuneifolia E. & Z.	
Rhoicissus cymbifoliolus Sm. & Shaw	
Rhoicissus digitata (L. f.) Gilg & Brandt	
Rhoicissus rhomboidea (E. Mey.) Planch.	
Rhus dentata Thb.	
Rhus incisa L. f.	
Rhus legati Schonl.	Red Currant
Rhus longispina E. & Z.	
Rhus pyroides Burch.	Suurbessie
Rhus refracta E. & Z.	
Rhus undulata Jacq.	
Ricinus communis L.	Castor Oil
Royena cordata E. Mey.	
Royena hirsuta L.	
Royena lucida L.	Swartbas
Royena simii O. K.	
Royena villosa L.	
Rubus affinis Weihe & Nees	Bramble
Rubus pinnatus Willd.	Bramble
Rubus rigidus Sm.	Bramble
Rumex sagittatus Thb.	
Salix capensis Thb.	River Willow
Sansevieria grandis Hook. f.	
Sansevieria thyrsiflora Thb.	
Sanicula europaea L.	
Sarcostemma viminale (L.) R. Br.	
Scabiosa tysonii L. Bol.	
Schoenoxiphium sparteum (Wahl.) Kuek.	
Schotia latifolia Jacq.	Boerboon
Schotia speciosa Jacq.	Boerboon
Scolopia flanaganii Sim	
Scolopia mundii (Arn.) Warb.	Red Pear
Scolopia zeyheri (Arn.) Szysz.	Thorn Pear
Scutia myrtina (Burm.) Kurz	Droog-my-keel
Secamone alpini Schultes	
Secamone frutescens Decne.	
Selaginella kraussiana A. Br.	
Selago corymbosa L.	
Selago galpinii Schltr.	
Senecio angulatus L. f.	
Senecio brachypodus DC.	
Senecio deltoideus Less.	
Senecio juniperinus L.	
Senecio macroglossus DC.	
Senecio paucifolius DC.	
Senecio pyramidatus DC.	
Senecio retrorsus DC.	
Senecio tamoides DC.	

Setaria flabellata Stapf	
Setaria neglecta de Wit	
Setaria sphacelata Stapf & Hubb.	
Sida triloba Cav.	
Sideroxylon inerme L.	White Milkwood
Solanum sodomaeum Dunal	Bitter Apple
Sporobolus capensis Kunth	
Sporobolus centrifugus (Trin.) Nees	
Sporobolus fimbriatus (Trin.) Nees	
Sporobolus indicus R. Br.	
Stereum lobatum (Kuntze) Fr.	
Stiburus alopecuroides Stapf	
Stipa dregeana Steud.	
Stoebe cinerea Thb.	Bobo-bos
Stoebe plumosa Thb.	
Stoebe vulgaris Levyns	
Streptocarpus rexii Lindl.	
Strophanthus speciosus Reber	
Sutera atropurpurea (Benth.) Hiern	
Syncolostemon densiflorus E. Mey.	
Teclea natalensis Engl.	
Tecomaria capensis (Thb.) Spach	Tecoma
Themeda triandra Forsk.	Rooigras
Trachypogon capensis Trin.	
Tragus koelerioides Aschers.	
Trichocladus ellipticus E. & Z.	Onderbos
Trimeria rotundifolia (Hochst.) Gilg	
Trimeria trinervis Harv.	
Tristachya hispida (Thb.) K. Schum.	
Tritonia lineata Ker	
Ursinia apiculata DC.	
Venidium arctotoides (L. f.) Less.	
Vepris lanceolata G. Don	White Ironwood
Virgilia capensis Lam.	Keurboom
Wahlenbergia rivularis Diels	
Xanthium spinosum L.	
Xymalos monospora Baill.	Lemonwood
Zaluzianskya capensis Walp.	
Zantedeschia aethiopica (L.) Spreng.	Arum Lily
Zinnia multiflora L.	
Zizyphus mucronata Willd.	Wag-'n-bietjie

ANIMALS

Bruchus rufulus Fahr.	Weevil
Chrysococcyx cupreus van Som	Emerald Cuckoo
Clamator serratus Sparr.	Black-creasted Cuckoo
Columba arquatrix Temm.	Bushdove
Lamprocolius nitens phoenicopterus Sw.	Cape Glossy Starling
Lanius collaris L.	Butcher Bird
Lycaon pictus Temm.	Wild Dog
Motacilla clara Shpe.	Gray-backed Wagtail
Nariscus cinctiventris Stal	
Poicephalus robustus Gm.	Cape Parrot
Prosopophora prosopidis var. *mimosae* Maskell	Thorn Tree Scale
Turacus corythaix Wagl.	Loerie
Upupa africana Bechst.	Hoopoe

GLOSSARY

Alternes	Different dominants in patches in the same locality.
Association	A climax community with two or more dominants.
Climax	The community in which an area ultimately terminates.
Consociation	A climax community with a single dominant.
Coppice	Growth from stumps.
Disclimax	A climax caused by man or domestic animals.
Ecotone	The transition zone between two communities.
Formation	A climax community.
Holard	The total water content of the soil.
Mesic	Pertaining to conditions of medium water supply.
Mesocline	A moist cool slope.
Mesophytic	Avoiding both extreme moisture and drought.
Postclimax	A more advanced stage than the climax, existing because of localised favourable conditions.
Preclimax	The vegetation preceding the climax.
Relict	A species or community belonging to a former vegetation type.
Sclerophyll	With small hard leaves.
Seral	Successional.
Sere	A stage in the succession.
Subclimax	A community simulating the climax because further development is inhibited by some disturbance.
Sucker	Shoot of subterranean origin.
Transect	A cross section of vegetation.
Woodland	Areas whose vegetation is composed essentially of woody plants.
Xeric	Pertaining to conditions of scanty water supply.
Xerocline	A hot dry slope.
Xerophilous	Requiring dry conditions.
Xerophytes	Plants of dry habitats, which are able to decrease the transpiration rate to a minimum when under water deficiency.
Xerophytic	Referring to xerophytes.

REFERENCES

ACOCKS, J. P. H. (In Press) *Veld types of South Africa.* Govt. Printer, Pretoria.

ADAMSON, R. S. (1929) The vegetation of the south-western region. *The Botanical Features of the South-western Cape Province.* The Speciality Press of South Africa Ltd.

AINSLIE, W. (1899) *Sixty-six years' residence in South Africa.* Fort Beaufort Printing and Publishing Co.

AITKEN, D. R. (1922) The effect of slope exposure on climate and vegetation of a hill near Maritzburg. *S. A. J. Sci.* Vol. 19.

ALBANY MUSEUM. (1931) *A guide to the vertebrate fauna of the eastern Cape Province.* Published by the Trustees.

AMM, S. E. (1894) Mimosa thorn nuisance. *Agric. J. C. G. H.* Vol. 7.

ANTI-MIMOSA. (1896) Mimosa pest. *Agric. J. C. G. H.* Vol. 9.

AYYAR, K. V. S. AND NARAYANASWAMY, K. (1949) *Varagu* poisoning. *Nature.* Vol. 163, No. 4154.

BAKER, F. S. (1944) Mountain climates of the western United States. *Ecol. Mono.* Vol. 14, No. 2.

BAKER, J. G. (1926) *The Leguminosae of tropical Africa.* Erasmus Press, Ghent.

BALCHIN, W. G. V. AND PYE, N. (1950) Observations on local temperature variations and plant responses. *J. Ecol.* Vol. 38, No. 2.

BARROW, G. (1806) *Travels in the interior of southern Africa.* Cadell and Davies, London.

BAYER, A. W. (1933) The relationship of vegetation to soil erosion in the Natal thornveld. *S. A. J. Sci.* Vol. 30.

BEADLE, N. C. W. (1940) Soil temperatures during forest fires and their effect on the survival of vegetation. *J. Ecol.* Vol. 28, No. 1.

(1951) The misuse of climate as an indicator of vegetation and soils. *Ecol.* Vol. 32, No. 2.

BEARD, J. S. (1944) Climax vegetation in tropical America. *Ecol.* Vol. 25, No. 2.

BELYEA, H. C. Wind and exposure as limiting factors in the establishment of forest plantations. *Ecol.* Vol. 6, No. 3.

BEWS, J. W. (1916) An account of the chief types of vegetation in South Africa with notes on the plant succession. *J. Ecol.* Vol. 4, Nos. 3 and 4.

(1917a) The plant succession in the thornveld. *S. A. J. Sci.*

(1917b) The plant ecology of the Drakensberg range. *Ann. Natal Mus.* Vol. 3, Part 3.

(1920) The plant ecology of the coast belt of Natal. *Ann. Natal Mus.* Vol. 4, No. 2.

(1921) Some aspects of botany in South Africa and plant ecology in Natal. *S. A. J. Sci.* Vol. 18.

(1925) *Plant forms and their evolution in South Africa.* Longmans Green and Co. London.

(1927) Studies in the ecological evolution of the angiosperms. *New Phytologist Reprint No.* 16. Wheldon and Wesley Ltd. London.

(1929) *The world's grasses.* Longmans Green and Co. London.

(1931) The ecological viewpoint. *S. A. J. Sci.* Vol. 28.

BOSAZZA, V. L. (1950) The rôle of humus in soil protection. *Frmrs. Wkly.* 6/9/50.

BRAIN, C. K. (1929) *Insect pests and their control in South Africa.* Nas. Pers. Cape Town.

BRAUN-BLANQUET, J. (1932) *Plant sociology.* McGraw-Hill Book Co. New York.

BROWN, D. M. (1941) Vegetation of Roan Mountain: a phytosociological and successional study. *Ecol. Mono.* Vol. 2, No. 1.

BROWN, N. E. (1915) Sansevieria. A monograph of all the known species. *Kew Bult.*

BURTON, A. W. (1950) Local history. *Man and his environment.* Buffalo Catchment Association, East London.

BURTT, B. L. (1938) Meerburgh's *Impatiens capensis. Kew Bult.*

BURTT-DAVY, J. (1922) The distribution and origin of Salix in South Africa. *J. Ecol.* Vol. 10, No. 1.

BURTT-DAVY, J. AND HOYLE, A. C. (1936) *Check list of forest trees and shrubs of the British Empire. No.* 2. *Nyasaland Protectorate.* Imperial Forestry Institute, Oxford.

(1940) *Check list of forest trees and shrubs of the British Empire. No.* 5. *Tanganyika.* Imperial Forestry Institute, Oxford.

CANNON, W. A. (1914) Specialization in vegetation and environment in California. *The Plant World.* Vol. 17, No. 8.

CARPENTER, J. R. (1938) *An ecological glossary.* Kegan Paul, Trench, Trubner and Co. Ltd., London.

CLEMENTS, F. E. (1905) *Research methods in ecology.* The University Publishing Co., Lincoln.
(1916) *Plant succession.* Carnegie Institute of Washington.
(1929) Experimental methods in adaption and morphology. *J. Ecol.* Vol. 17, No. 2.
(1934) The relict method in dynamic ecology. *J. Ecol.* Vol. 22, No. 1.
(1935) Experimental ecology in the public service. *Ecol.* Vol. 16, No. 3.
(1936) Nature and structure of the climax. *J. Ecol.* Vol. 24, No. 1.

COHEN, C. (1935) *Stoebe* sp. A contribution to its ecology. *J. S. A. Bot.* Vol. 1, Part 4.
(1940) *Stoebe vulgaris.* A study of an ecological problem. *J. S. A. Bot.* Vol. 6, Part 2.

COLLINS, W. F. AND WILD, H. (1950) *Poisonous plants of the Marandellas district.* Govt. Printer, Salisbury.

COOK, L. (1939) A contribution to our information on grass burning. *S. A. J. Sci.* Vol. 36.

CORY, G. E. (1920) Grahamstown. *A souvenir in commemoration of the centenary of the* 1820 *settlers of Albany.* East London Daily Dispatch.

COTTAM, W. P. AND EVANS, F. R. (1945) A comparative study of grassed and ungrassed canyons of the Wasatch range, Utah. *Ecol.* Vol. 26, No. 2.

COX, F. C. (1933) Alpine plant succession on James Peak, Colorado. *Ecol. Mono.* Vol. 3, No. 3.

CURSON, H. H. (C. 1926) *Some little-known South African poisonous plants and their effects on stock.* Paper read at 7th Ann. Sci. Meeting of the S.A. Vet. Med. Assoc. Pretoria. Published by the Association.

DANSEREAU, P. (1951) Description and recording of vegetation upon a structural basis. *Ecol.* Vol. 32, No. 2.

DORRIEN-SMITH, A. A. (1908) Notes (without title) on the sub-antarctic islands. *Kew Bult.*

D.W.G.S. (1949) Kalahari sand to clothe the Karroo. *Fmrs. Wkly.* 19/1/49.

DYER, R. A. (Mss.) Notes on *Acacia karroo.* Botanical Survey, Grahamstown.
(1929) Veld experiments on the Amatola mountains. *Dept. Agric. First Trienn. Conf., Report of Proc.* Govt. Printer, Pretoria.
(1930) The control of mimosa trees and scrub bush. *Farming in South Africa.* Vol. 4, March 1930.
(1931) Eradication of Acacia scrub or thorn bush. *Farming in South Africa.* Vol. 5, Feb. 1931.
(1932) Control of *Selago corymbosa. Farming in South Africa.* Vol. 6, March 1932.
(1935) The seed germination of certain species of Euphorbia. *S. A. J. Sci.* Vol. 32.
(1937) The vegetation of the divisions of Albany and Bathurst. *Mem. Bot. Surv. S. Afri.* No. 17.

EAMES, A. J. AND MACDANIELS, L. H. (1925) *Introduction to plant anatomy.* McGraw-Hill Book Co., New York and London.

E.W. (1896) Thorn tree scale. *Agric. J.C.G.H.* Vol. 9.

EWART, A. J. (1908) *The longevity of seeds.* Proc. Roy. Soc. Victoria. (Quoted by Guppy).

FENTON, E. W. (1934) Grassland retrogression in Devonshire permanent pastures. *J. Ecol.* Vol. 22, No. 1.

FLORA CAPENSIS. Reeve and Co., London.

FOURCADE, H. G. (1942) Some notes on the effects of incidence of rain on the distribution of rainfall over the surface of unlevel ground. *Trans. Roy. Soc. S. Afri.* Vol. 29, Part 3.

GALPIN, E. E. (1926) Botanical survey of the Springbok Flats, Transvaal. *Mem. Bot. Surv. S. Afri.* No. 12.

GERSTNER, J. (1948) Three closely-related Acacias of southern Africa. *J. S. A. Bot.* Vol. 14, Part 1.

GILBERT, L. C. (1949) Letter to *Fmrs. Wkly.* 23/11/49.

GILL, L. (1945) *A first guide to South African birds.* Maskew Miller, Cape Town.

GLEASON, N. A. (1912) Relation of the prairie and forest in Central Illinois. *Bot. Gaz.* Vol. 53.

GLUCKMANN, E. (Ms.) Notes on *Themeda triandra.* Botany Dept., University of the Witwatersrand.

GOLA, G. (1905) *Ricerche sulla biologia e sulla fisiologia de semi a tegumento impermeabile.* Royal Academy of Sciences, Turin. (Quoted by Guppy).

GREATHEAD, H. H. (1894) Mimosa thorn. *Agri. J.C.G.H.* Vol. 7.

GRIGGS, R. F. (1936) The vegetation of the Katmai district. *Ecol.* Vol. 17, No. 3.
(1938) Timberlines in the northern Rocky Mountains. *Ecol.* Vol. 19, No. 4.

GUPPY, H. B. (1912) *Studies in seeds and fruits.* Williams and Norgate, London.

HABERLANDT, G. (1928) *Physiological plant anatomy.* Macmillan and Co. Ltd., London.

Hall, H. (1856) Map of the eastern frontier of the Cape Colony. Edward Stanford, London.

Hann, J. (1903) *Handbook of climatology.* Translated by D. C. Ward. New York. (Quoted by J. Phillips).

Hanson, H. C. (1950) Vegetation and soil profiles in some solifluction and mound areas in Alaska. *Ecol.* Vol. 31, No. 4.

Hartley, W. (1950) The global distribution of tribes of the Gramineae in relation to historical and environmental factors. *Austr. J. Agri. Res.* Vol. 1, No. 4.

Henkel, J. S. (1932) The wattle bagworm. An ecological study. *S.A.J. Sci.* Vol. 29.
(1934) *The woody plants of Natal and Zululand.* Robinson and Co. Ltd., Durban.
(1947) Humus as it occurs naturally in various African plant associations. *The Farmer.* 3/4/47.

Henkel, J. S., Bayer, A. W. and Coutts, J. R. H. (1938) Subsurface erosion on a Natal midlands farm. *S.A.J.Sci.* Vol. 35.

Hendler, M. (1949) Olive oil in the Boland. *Fmrs. Wkly.* 26/1/49.

Henrici, M. (1926) Growth of veld plants under arid conditions of Bechuanaland. *S.A.J.Sci.* Vol. 23.

Hermenau, K. (1949) Thornbush camps for better grazing. *Fmrs. Wkly.* 11/9/49.

Hesse, A. J. (1938) Some adaptive responses of insect life in semi-arid conditions in South Africa. *S.A.J.Sci.* Vol. 35.

Hewitt, J. (1920) Notes on the Eastern Province in pre-settler times. *Souvenir in Commemoration of the Centenary of the* 1820 *Settlers of Albany.* East London Daily Dispatch.

Hitchcock, H. S. (1929) The relation of grasses to man. *S.A.J.Sci.* Vol. 26.

Hobson, S. (1896a) Deterioration of the veld. *Agri.J.C.G.H.* Vol. 9.
(1896b) The mimosa. *Agric. J.C.G.H.* Vol. 9.

Houghton, D. H. (In Press) *An economic survey of the Keiskammahoek district.* Nat. Counc. Soc. Res., Pretoria.

Howard, A. (1925) The effect of grass on trees. *Proc. Roy. Soc.* Series B. Vol. 97.
(1940) *An agricultural testament.* Oxford University Press.

Hutchins, D. E. (1887) *Forests and tree planting in the eastern districts.* Paper read at Queen's Jubilee Exhibition, Grahamstown. Ms. Botanical Survey, Grahamstown.
(1892) Age of old mimosa tree in parliament house grounds. *Agri. J.C.G.H.* Vol. 5.

Hutchinson, J. (1934) *The families of flowering plants.* Macmillan and Co. Ltd., London.

Irrigation Dept. (1939) *Rainfall map of the Union of South Africa.* Govt. Printer, Pretoria.

Irvine, L. O. F. (1941) *The major veld types of the northern Transvaal and their grazing management.* Ms. Quinquennial report of the Towoomba pasture Research station.

Jeans, J. (1948) *The stars in their courses.* Cambridge University Press.

Jubb, A. E. (1945) *The evolution of the magisterial district of Keiskamahoek.* Ms. Public Library, Keiskammahoek.

Kendrew, W. G. (1922) *The climates of the continents.* Clarendon Press, Oxford.

Killick, D. J. B. (1950) *The ecology of the Table Mountain area, Pietermaritzburg, Natal.* M.Sc. Thesis, Natal University.

Kotsokoane, J. (Ms.) Notes on pasture analysis on the Hogsback. Botany Dept., Witwatersrand University.

Kramer, P. J. (1944) Soil moisture in relation to plant growth. *Bot. Rev.* Vol. 10, No. 9.

Leighly, G. (1937) A note on evaporation. *Ecol.* Vol. 18, No. 2.

Leighton, G. (1917a) Some suitable materials for papermaking. *S.A.J. Sci.*
(1917b) Notes on the fibre produced from some of the most useful indigenous and exotic plants in the Cape Province. *S.A.J. Sci.*

Leppan, H. D. (1928) *The agricultural development of arid and semi-arid regions, with special reference to South Africa.* Central News Agency.

Levyns, M. R. (1935) Germination in some South African seeds. *J.S.A.Bot.* Vol. 1, Part 4.
(1937) A revision of Stoebe L. *J.S.Afri.Bot.* Vol. 3, Part 1.
(1938) Some evidence bearing on the past history of the Cape flora. *Trans. Roy. Soc. S. Afri.* Vol. 26, Part 4.

Lichtenstein, H. (1812) *Travels in southern Africa.* Translated from the original German by Anne Plumptre. Henry Colburn, London.

Liebenberg, C. D. B. (Ms.) Notes on *Passerina montana.* Botanical Survey, Albany Musem.

Lounsbury, C. P. (1896) Thorn tree scale. *Agri. J.C.G.H.* Vol. 13.

Macbride, J. F. (1950) Natural Landscapes of the United States. *Chicago Nat. Hist. Mus. Pop. Ser. Botany,* No. 27.

McGinnies, W. G. and Arnold, J. F. (1939) Relative water requirements of Arizona range plants. *Univ. of Arizona. Tech. Bult.* 80.

Macowan, P. (1886) Personalia of botanical collectors at the Cape. *Trans. S. Afri. Phil. Soc.* Vol. 4.

(1890) The gum of the mimosa. *Agri. J.C.G.H.* Vol. 3.

(1897) The olive at the Cape. *S.A. Agriculturalist's Year Book and Almanac.* Wynberg Times Steam Printing Works, Wynberg.

Marloth, R. (1901) Notes on the occurence of alpine types in the vegetation of the higher peaks of the south-western region of the Cape. *Trans. S.Afri. Phil. Soc.* Vol. 2, Part 3.

(1908) *Das Kapland.* Gustav Fischer Jena.

(1913–1925) *The flora of South Africa.* Darter Bros. and Co., Cape Town.

Maximov, N. A. (1929) *The plant in relation to water.* George Allen and Unwin, London.

(1931) Physiological significance of xeromorphic structure in plants. *J. Ecol.* Vol. 19.

Meredith, D. (1947) *Fertilizing grasses in South Africa.* Agricultural Advisory Section, African Explosives and Chemical Industries Ltd., Johannesburg.

Meteorological Office (1942) *Temperature.* Govt. Printer, Pretoria.

Meyer, B. S. and Anderson, D. B. (1940) *Plant physiology.* Chapman and Hall, London.

Michelmore, A. P. G. (1939) Observations on tropical African grasslands. *J.Ecol.* Vol. 27, No. 2.

(1947) A popular misconception regarding humidity and the need for closer liaison between meteorologists and ecologists. *J. Ecol.* Vol. 34, No. 1.

Mines, Dept. of (1946) Geological Survey. *Map* 136, *Grahamstown.*

Mogg, A. O. D. (1929) The flora of the Vryburg district in relation to the geology. *Compte Rendu.* Vol. 2. 15th International Geological Congress.

Muir, J. (1929) The vegetation of the Riversdale area. *Mem. Bot. Surv. S.Afri.* No. 13.

Murray, G. (In Press) *Report on the reconnaisance soil survey of Keiskammahoek district, Cape Province.* Nat. Counc. Soc. Res., Pretoria.

Murray, S. M. and Glover, P. (1935) A preliminary study of the root development of certain South African highveld grasses. *J.S.A.Bot.* Vol. 1, Part 2.

Osborn, J. B. and Osborn, E. (1931) Studies on the germination of seed of the black wattle (*Acacia mollissima*), and the green wattle (*Acacia decurrens normalis*), *S.A.J.Sci.* Vol. 28.

Pappe, L. (1862) *Silva capensis.* W. Brittain, Cape Town.

Pentz, J. A. (1938) The value of botanical survey and the mapping of vegetation as applied to farming systems in South Africa. *Mem. Bot. Surv. S. Afri.* No. 19.

Pessin, L. J. (1925) An ecological study of the Polypody fern *Polypodium polypodioides* as an epiphyte. *Ecol.* Vol. 6, No. 1.

Phillips, J. (1926) *Virgilia capensis* Lamk. A contribution to its ecology and silviculture. *S.A.J.Sci.* Vol. 23.

(1927) The rôle of the bushdove in fruit dispersal in the Knysna forests. *S.A.J.Sci.* Vol. 24.

(1928a) The principal forest types in the Knysna region. *S.A.J.Sci.* Vol. 25.

(1928b) The loerie in the Knysna forests. *S.A.J.Sci.* Vol. 25.

(1929) The influence of *Usnea* sp. upon the supporting tree. *Trans. Roy. Soc. S. Afri.* Vol. 17.

(1930) Fire: its influence on biotic communities and physical factors in South and East Africa. *S.A.J.Sci.* Vol. 27.

(1931) Forest succession and ecology in the Knysna region. *Mem. Bot. Surv. S. Afri.* No. 14.

(1934) Succession, development, the climax and the complex organism. An analysis of concepts. Part 1. *J. Ecol.* Vol. 22, No. 2.

Pickford, G. E. (1926) The Kommetjie Flats. *The Blythswood Review.* May 1926.

Pilson, C. A. and Higgs, T. (Ms.) *Geography. Climate.* Geography Dept., Rhodes University.

Pio, M. (1948) Strange story of six sheep. Reported in *Fmrs. Wkly.* 21/7/48.

Pole Evans, I. B. (1935) A vegetation map of South Africa. *Mem. Bot. Surv. S. Afri.* No. 15.

(1922) The main botanical regions of South Africa. *A guide to Botanical Survey Work.* Govt. Printer, Pretoria.

Polunin, N. (1934) The vegetation of Akpatok island. *J. Ecol.* Vol. 22, No. 2.

Potts, G. and Tidmarsh, C. E. (1937) An ecological study of a piece of karroo-like vegetation near Bloemfontein. *J.S.A.Bot.* Vol. 3, Part 2.

Potzger, J. E. (1939) Microclimate and a notable case of its influence on a ridge in central Indiana. *Ecol.* Vol. 20, No. 1.

Pringle, T. (1835) *Narrative of a residence in South Africa.* Edward Moxton, London.

Rawitscher, F. (1948) The water economy of the vegetation of the campos cerrados in southern Brazil. *J. Ecol.* Vol. 36, No. 2.

Rennie, J. V. L. (1935) On the flora of a high mountain in South-west Africa. *Trans. Roy. Soc. S. Afri.* Vol. 23, Part 3.

Reynolds, G. W. (1950) *The aloes of South Africa.* Published by the Trustees, the Aloes of South Africa Book Fund, Johannesburg.

Riley, N. E. (1950) Report on proceedings of the Royal Entomological Society of London. Vol. 15, No. 11.

Rowland, J. W. and Hector, J. M. (1932) An analysis of the grazing conditions on a Potgietersrust farm. *S.A.J.Sci.* Vol. 29.

Rose-Innes, R. (1937) *Secondary succession in the highveld area of the Transvaal.* B.Sc. (Hons.) Thesis, University of the Witwatersrand.

Russell, J. (1949) The world problem of increasing food supplies. Reported in *World Crops.* Vol. 1, No. 2.

Russell, R. S. and Wellington, P. S. (1940) Physiological and ecological studies on an arctic vegetation. The vegetation of Jan Mayen island. *J. Ecol.* Vol. 28, No. 1.

Salisbury, E. (1949) Leaf form and function. *Nature.* Vol. 163, No. 4144.

Schauder, R. (1949) Unsatisfied demand for aloe juice. *Fmrs. Wkly.* 23/11/49.

Schelpe, E. A. C. (1946) *The plant ecology of the Cathedral Peak area.* M.Sc. Thesis, Natal University.

Schimper, A. F. W. (1903) *Plant geography upon a physiological basis.* Translated by W. Fisher. Clarendon Press, Oxford.

Schonken, J. D. (1930) The state of our natural water supply. *S.A.J.Sci.* Vol. 27.

Schonland, S. (1923) The Amatola problem. *Fmrs. Wkly.* 31/10/23.

(1927) On the reclamation of ruined pasture on the Amatolas near Keiskama Hoek. *Sci. Bult. Dept. Agri. S. Afri.* No. 55.

Schulze, B. R. (1947) The climates of South Africa according to the classifications of Köppen and Thornthwaite. *S.A.Geol. Jour.*

Sclater, W. L. (1900) *The mammals of South Africa.* Vol. 1. R. H. Porter, London.

Scott, J. D. (1949) *A contribution to the study of the Drakensberg conservation area.* D.Sc. Thesis, University of the Witwatersrand.

Shreve, F. (1914) Rainfall as a determinant of soil moisture. *The Plant World.* Vol. 17, No. 1.

(1917) The establishment of desert perennials. *J. Ecol.* Vol. 5, Nos. 3 and 4.

Sim, T. R. (1894) *Sketch and check list of the flora of Kaffraria.* Published by the King William's Town Natural History Society.

(1900) Botanical observations on the forests of east Pondoland. *Agri. J.C.G.H.* Vol. 16.

(1907) *The forests and forest flora of the colony of the Cape of Good Hope.* Taylor and Henderson, Aberdeen.

(1915) *The ferns of South Africa.* Cambridge University Press.

(1926) Some effects of man's influence on the South African flora. *S.A.J.Sci.* Vol. 23.

Skaife, S. H. (1926) The bionomics of the Bruchidae. *S.A.J.Sci.* Vol. 23.

Skottsberg, C. (1945) *The Juan Fernandez and Desventuradas islands.* The Chronica Botanica Co., Waltham, Mass., U.S.A.

Smuts, J. C. (1932) Climate and man in Africa. *S.A.J.Sci.* Vol. 29.

Snowden, J. D. (1933) A study in altitudinal zonation in south Kigezi and on mounts Muhavura and Mgahinga, Uganda. *J.Ecol.* Vol. 21, No. 1.

Solereder, H. (1908) *Systematic anatomy of the dicotyledons.* Translated by Boodle and Fritsch, Clarendon Press, Oxford.

Stal, C. (1864) *Hemiptera africana.* Stockholm.

Stapf, O. (1906) The oil-grasses of India and Ceylon. *Kew Bult.*

Staples, R. R. and Hudson, W. K. (1938) *An ecological study of the mountain area of Basutoland.* Garden City Press Ltd., Letchworth, Herts., England.

Stent, S. M. (1924) South African gramineae. *Bothalia.* Vol. 1, Part 4.

(1925) Bramble eradication. *Fmrs. Wkly.* 4/2/25.

Stevenson-Hamilton, J. (1937) *South African Eden.* Casell and Co., London.

Steyn, D. G. (1934) *The toxicology of plants in southern Africa.* Central News Agency.

Story, R. (1939) Notes on two important grassland types in the Vereeniging district. *S.A.J.Sci.* Vol. 36.

Tansley, A. G. (1923) Practical plant ecology. George Allen and Unwin Ltd., London.

(1934) Editorial comment. *J.Ecol.* Vol. 22, No. 1.

Theron, J. J. (undated) Lysimeter experiments. *Sci. Bult. Dept. Agri. S. Afri.* No. 288.

Thoday, D. (1924) A revision of Passerina. *Kew Bult.*

(1933) The terminology of xerophytism. *J.Ecol.* Vol. 21, No. 1.

Thomas, A. S. (1943) The vegetation of the Karamoja district, Uganda. *J. Ecol.* Vol. 31.

Thornthwaite, C. W. (1940) Atmospheric moisture in relation to ecological problems. *Ecol.* Vol. 21, No. 1.

Tooke, W. H. (1905) Notes on the geographical distribution of the Hottentot and Bantu in South Africa. *Rec. Albany Mus.* Vol. 2, Part 5.

Van Reenen, R. J. (1923) A résumé of the drought problem in South Africa. *S.A.J.Sci.* Vol. 22, No. 1.

Van Riet Lowe, C. (1938) Early man and past climates in South Africa. *S.A.J.Sci.* Vol. 35.

Versveld, W. and Britten, G. F. (1915) Notes on the chemistry of the Naras. *S.A.J.Sci.*

WALTER, H. (1927) *Einfuhring in die Allgemeine Pflanzengeographie Deutschlands.* Gustav Fischer, Jena.

WARMING, E. AND VAHL, M. (1909) *Oecology of plants.* Clarendon Press, Oxford.

WATT, J. M. AND BREYER-BRANDWIJK, M. G. (1932) *The medicinal and poisonous plants of South Africa.* E. and S. Livingstone, Edinburgh.

WEAVER, J. E. AND CLEMENTS, F. E. (1929) *Plant ecology.* McGraw-Hill Book Co. Inc., New York.

WEIMARCK, H. (1934) *Monograph of the genus Cliffortia.* H. Ohlsson, Lund.

WELLS, H. G., HUXLEY, J. AND WELLS, G. P. (Undated) *The science of life.* The Waverley Book Co., London.

WEST, O. (1951) The vegetation of Weenen county, Natal. *Mem. Bot. Surv. S. Afri.* No. 23.

WHITE, F. J. S. (1948) *The Helichrysum weed problem on the Amatolas near Keiskamma Hoek.* B.Sc. Hons. Thesis. University of the Witwatersrand.

WHITLOCK, L. (1949) Reply to query in *Fmers. Wkly.* 12/10/49.

WHITMORE, J. S. (1949a) Frost. *Farming in South Africa.* Vol. 24, No. 277.

(1949b) Rains fall to design of nature's architecture. *Fmrs. Wkly.* 16/2/49.

WICHT, C. L. (1949) Forestry and water supplies in South Africa. *Bult. Dept. For. S. Afri.* No. 33.

WILD, H. (1950) Evidence for the existence of ecotypes of the Msasa in Southern Rhodesia. *S.A.J.Sci.* Vol. 47, No. 4.

WILLIS, J. C. (1919) *A dictionary of the flowering plants and ferns.* Cambridge University Press.

WOLHUTER, H. (1948) *Memories of a game ranger.* Wild life Protection Society of South Africa. Distributed by Central News Agency.

WOOD, J. G. (1934) The physiology of xerophytism in Australian plants. *J. Ecol.* Vol. 22, No. 1.

WOODARD, J. (1925) Factors influencing the distribution of tree vegetation in Champaign county, Illinois. *Ecol.* Vol. 6, No. 2.

ZEUNER, F. E. (1949) Time in evolution. *Rep. Smithson. Instn.*

APPENDIX

PRACTICAL POINTS REGARDING THE WORKING OF METEOROLOGICAL INSTRUMENTS

The instruments were installed according to the cyclostyled instructions of the Union Division of Meteorology. In addition, the *Meteorological Observer's Handbook* was consulted, and *Notes on Meteorological Instruments and Observations* (1938). A number of difficulties not mentioned in these papers was encountered during the year's observations, and it is felt that a discussion of them may be useful to future workers.

The Stevenson screen contains two shelves, respectively for the thermograph and the hygrograph. The space for these instruments is too cramped to allow one to give them their routine weekly attention where they stand, and for this they have to be taken off the shelves. It is convenient to place them in a shady place on the ground so that every part is easily accessible, but in rainy weather this is not practicable, and they have to be brought forward to straddle the edge of the opening of the screen before they can be attended to. This is inconvenient and risky, for they rest on a narrow ledge and cannot with safety be left unsupported. It would be an improvement to the screen if it had a light wooden frame like a picture frame hinged to the bottom shelf and fastened to the upper shelf by a catch, so that the frame could be let down to support the instrument when the screen was opened. The suggested addition is shown in Figure 15.

Rainy weather was the biggest source of trouble when the instruments had to be visited. The drops drive into the screen, wet the pens, smudge the charts and get into the mechanism of the instruments. A shelter over the screen is a necessity at such times, and could best be made from the plastic material used for waterproof capes. This, being light and transparent, could be easily stored in the screen or carried, and would not obscure the light—an important consideration on a dull day. It could be secured by catches on the outside of the screen along the front edges, with corresponding metal eyes let into the material.

The construction of the fonts supplying the distilled water to the wet bulb thermometers was the cause of a good deal of wasted time. The neck of the font is so narrow that one has difficulty in pouring in the distilled water in a stream fine enough to prevent a bubble forming in the neck and blocking the entrance. It requires a steady hand under the best conditions and becomes a lengthy and tedious process on a windy day. It would be better to have the wick passing through a small hole in a metal cap screwing on to a neck with a wider opening. In addition, the fonts should be made slightly larger. There is a risk of the water's becoming exhausted in dry and windy weather.

The recording instruments were of various makes, each with its own good features and weaknesses. The points which follow should be kept in mind by any worker who is in a position to select his instrument.

Most of the drums are secured by a locking nut on the top end of the spindle. It has the standard right-hand thread, with the result that when the clockwork is set in motion the rotation tends to screw the nut more and more tightly down on the top of the drum. Until this was discovered, the instruments were continually being halted by the increased friction which was caused. The nut was thereupon discarded, but this allowed the drum to wobble when the chart was being adjusted to the correct time at the beginning of its run, and there was consequent difficulty in getting an accurate and neat time mark. The spindle should be fitted with a left-hand thread, or the drum secured by a strong clip.

The usual device for holding the chart on the drum is a metal bar. In some of the instruments it is hooked to fit over the top rim of the drum, and is flat at its lower end so that it can be thrust through a slot in the flange at the base of the drum. The metal bar and the drum are usually of equal length, which means that it is impossible to put the bar in position unless both ends engage the drum at the same instant. This is shown in Figure 16. To add to the difficulty, the bar is springy and slightly curved to ensure that the chart will be firmly gripped. More than once, when numbed fingers failed to hold the bar properly, it slipped off the drum and was flicked away by its own tension. The bar should be appreciably longer than the drum, and an improvement which is found in some of the instruments is a bar hinged to the drum at one end and with the free end provided with a catch to hold it when in position.

The disadvantage of all the bar mechanisms is that one has to take care that the chart is fitted so that the bar does not cover the position where the pen should be. This is liable to happen in the mornings, because the lines marking the early hours are close to the edge of the chart, where the bar must grip. If this does occur, one is faced with the nuisance of removing the chart, rotating it slightly and replacing it. The possibility is avoided in some instruments which have their charts with one of the edges gummed and overlapping the other, and easily detachable at the end of the period by means of suitably placed perforated lines separating it from the body of the chart. Wet weather did not cause the gum to slip. It was found to hold the chart firmly under all conditions.

Chart MET 20 for thermographs is apt to give trouble unless it is trimmed a little. The gridded portion of the chart, that is the chart not counting the space for captions, has too much overlap. The consequent difficulty is shown in Figure 17. Let us suppose that the instrument is beginning its run at 8 a.m. The pen should start its record at point A, but this point is covered by the other end of the chart no matter what the position of the chart may be with respect to the bar. It is possible to fold the outer end upwards, as shown, and place the pen beneath it, but towards the end of the week the raised flap of paper will lift the pen away from the chart when it approaches its original position. The only way of dealing with this imperfection is to tear away the free end of the chart flush with the edge of the bar.

The hygrographs have the strands of hair protected by a cover of coarse wire mesh. The cover interferes with the washing of the hair, and could be with advantage hinged so that it could be easily moved aside when necessary.

Most instruments have a motor which runs for only a little more than a week with one winding. Inevitably the operator will at some time forget to wind one of the motors, thereby ruining a set of records. A 14-day motor would make this mistake a harmless one, and a 14-day motor is quite practicable. One of the instruments had a motor which ran for over three weeks with one winding.

The drum should be removable. In one thermograph the drum was a fixture. It was an awkward task to change the charts even in fine weather, and a great deal more difficult under bad conditions.

The meshing of the drum with the motor should be perfect. One of the drums, even though not fully home on its seat, could still engage with the driving cog of the motor. This fault, a difficult one to notice, resulted in a chart with readings too low, and corrections had to be applied in consequence.

The key for winding the motor should be a fixture. One is liable to mislay loose keys and they are a nuisance to carry round from one instrument to the next.

The bar for lifting the pen off the chart should be firm and perpendicular. One had a slight outward bias, and sometimes interfered with the working of the pen when it was near the upper limit of its range. Here again it was difficult to discover where the trouble lay. It would be an advantage to have a double bar—the usual one between the pen and the drum, and another between the pen and the front of the instrument, to prevent the pen from touching the glass panel there. It is not possible to erect the screen so that it will remain entirely rigid in a strong wind, and the vibration set up during a spell of windy weather, together perhaps with blasts of air into the screen, are sometimes enough to swing the pen away from the drum so that the back of the ink reservoir comes in contact with the glass. The slightest smear of ink on the outside of the reservoir will make it stick. A makeshift aid is to rub a candle-end over the inside of the glass panel opposite the ink reservoir. The thin film of grease will prevent the trouble.

It sometimes happens that the pens are blown violently about if the charts are changed in windy weather, and a double bar would have the added advantage of protecting them from injury.

Some pens have their hinges not perpendicular to the base of the instrument but set with a slight bias, sufficient to hold the nib against the drum. The weight of the pen is often too little for the nib to make a legible mark, and a temporary solution is to tilt the whole instrument slightly back by placing a thin strip of cardboard under the front feet. It is preferable to use instruments which have pens with an adjustable pressure against the drum.

The days of the week should not be marked on the charts. Field workers with a battery of instruments cannot as a rule change the charts every seventh day because only the morning hours of the seventh day are marked on the chart. Where the instruments are numerous or far apart, the work extends into the afternoon and the instruments attended to then will be found with their pens off the end of the chart, consequently it is necessary to change the charts every sixth day, and for this reason the initial day on the charts changes with each run. The thermograph charts should in addition not have the temperatures marked up on them. Seasons may be extreme enough to send the pen off the chart unless the pen is adjusted to read high or low as the case may be. Marked charts have to be endorsed accordingly and are confusing to read. A further improvement would be to have the hours on the charts marked according to the 24-hour clock. The 12-hour system is cumbersome and out of place in formally scientific work.

For the routine handling of the instruments, the following supplies were found necessary:—

1. Charts.
2. Muslin and wicks.
3. Ink for instrument pens.
4. Keys for screen locks.
5. Distilled water.
6. Keys for clockwork motors.
7. Camel-hair brush.
8. Benzine.
9. Razor-blade.
10. Notebook.
11. Thin oil.
12. Alcohol.
13. Filter-paper.
14. Small screwdriver.

The use of items 1 to 7 is either explained in the meteorological instructions cited or is self-evident. The charts, rolled face outward, were carried in a round tin, and when withdrawn for use retained their cylindrical form, which made it easier to fit them round the drum. The old charts were dried with filter-paper and stored in a separate tin.

There was not enough ink to allow a supply to be stored in each screen, but this would have been the best arrangement because the bottles could never be kept perfectly clean and were an endless source of anxiety in the haversack which was used to transport the supplies.

The benzine was used for flushing out the working parts of the instruments when this was necessary. It was applied with a fine brush and the excess was removed with a piece of the muslin used for the wet bulb thermometer.

When working with the wet bulb thermometers, it was found to be quicker to twist the wicks than to plait them as shown in *Notes on Meteorological Instruments and Observations.* The four strands, after having been knotted at the muslin, were combined to form two sets of two. These were rolled each in the same direction, then placed side by side and rolled in the opposite direction to form the necessary cord. The muslin was cut free by means of a razor-blade when ready for changing.

When the charts were changed it was found advisable to enter the relevant details in a notebook and copy them on the chart in ink later. This gave a neater chart and helped to make the extraction of the figures easier.

To give a smooth action, thin oil was sometimes needed on the moving parts of the instruments. The merest trace, applied on the end of a grass-stalk, was all that was necessary. Any tendency for the oil to spread to other parts of the instrument could be checked by cleaning with benzine.

Alcohol was useful for cleaning spots of recording ink off the instruments, and from time to time it was needed for washing the reservoirs on the pens when they became clogged with an accumulation of old ink.

For minor adjustments and repairs a small screwdriver was carried.

The one new instrument of the set could be depended upon to work, within its mechanical limitations, perfectly from one week to the next. The others gave a great deal of trouble, and any break in the record of one instrument meant that the rest of the readings for this period had to be discarded, otherwise the records for the five stations would not have been comparable. The most serious gaps in the records were caused by break-downs in the motors and by nibs which would fail, without warning, to trace their mark on the chart. The number of breaks may be seen from Figures 1 and 2, in Chapter 1. Complete records from all five stations were obtained on only 178 days in the year. With new motors and new ink reservoirs on the pens it should be possible to get a year's records practically complete for any number of stations. A spare hygrograph and a spare thermograph should be kept, to be substituted for any instrument which may become faulty and require adjustment or repairs.

Some of the recommendations are for very small improvements. An accumulation of petty annoyances in conjunction with a number of serious difficulties, however, can and does turn a smooth routine into an exacting and difficult task, and instruments should be most carefully examined for constructional shortcomings before being put to use, specially in parts far from the main station.

The rainfall was measured according to the standard meteorological procedure. Improvements on these methods have been suggested by Fourcade (1942).

REFERENCES

FOURCADE, H. G. (1942) Some notes on the effects of incidence of rain on the distribution of rainfall over the surface of unlevel ground. *Trans. Roy. Soc. S. Afri.* Vol. 29, Part 3.

METEOROLOGICAL OBSERVER'S HANDBOOK (1942) H.M. Stationery Office, London.

NOTES ON METEOROLOGICAL INSTRUMENTS AND OBSERVATIONS (1938) Publication I.D. 278, Govt. Printer, Pretoria.

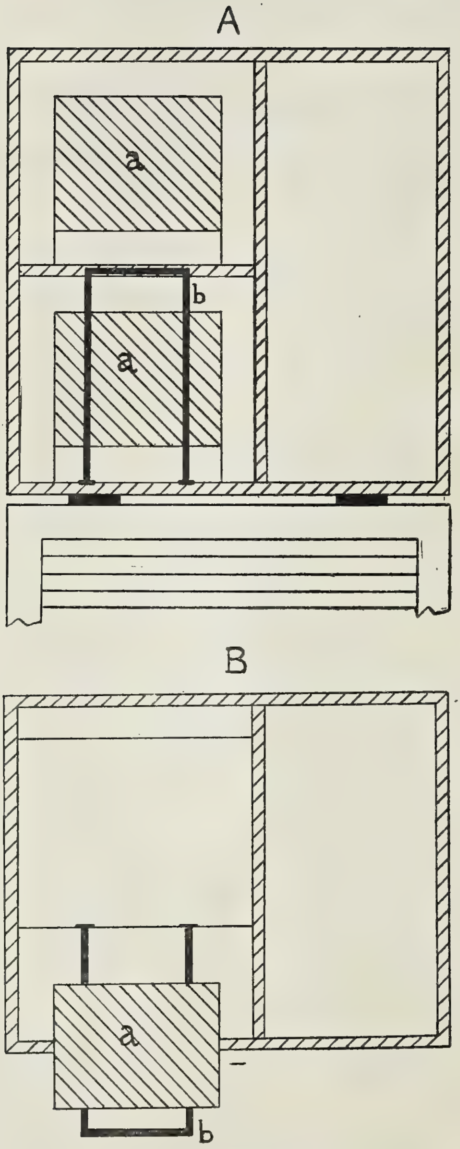


Fig. 15—Suggested Improvement to Stevenson Screen.

A. Front Elevation, B. Plan, a. instrument, b. hinged frame to support instrument when charts are changed.

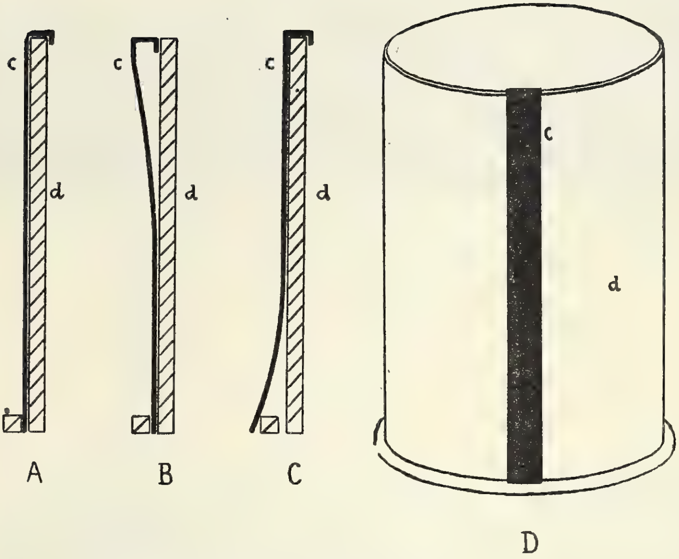


Fig. 16—Shortcomings of the Clip Mechanism.

A, D. Clip in position on drum
B. Clip engaged at base only
C. Clip engaged at top only
c. clip
d. drum

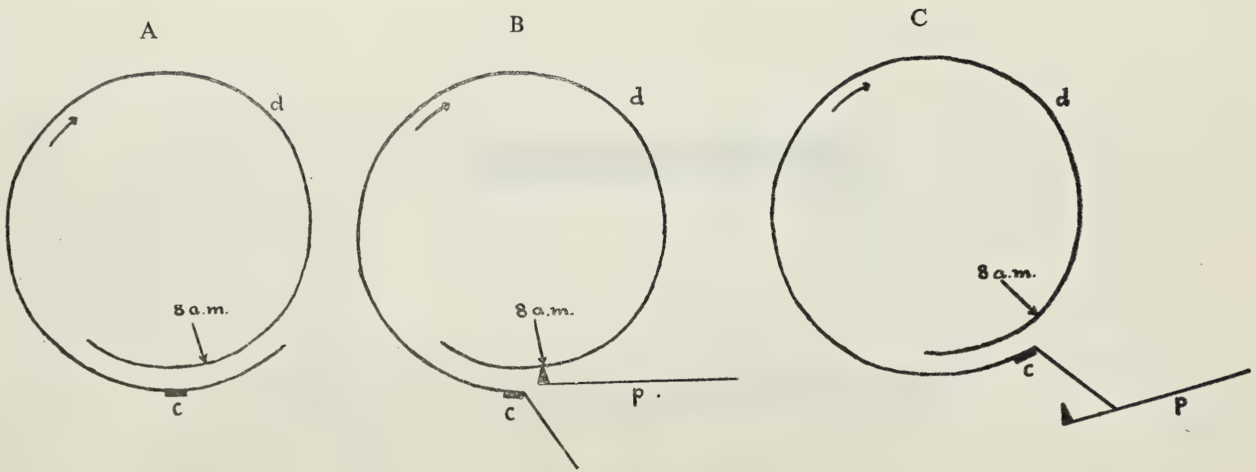
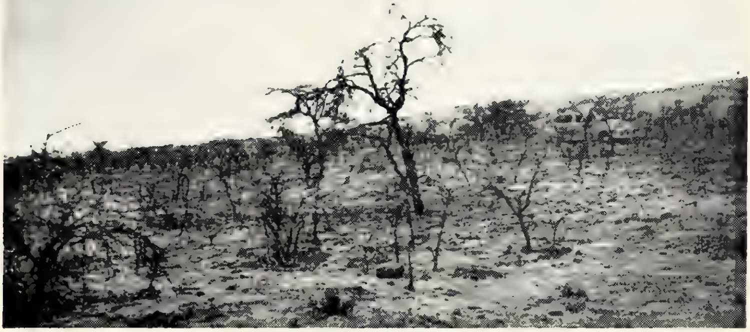
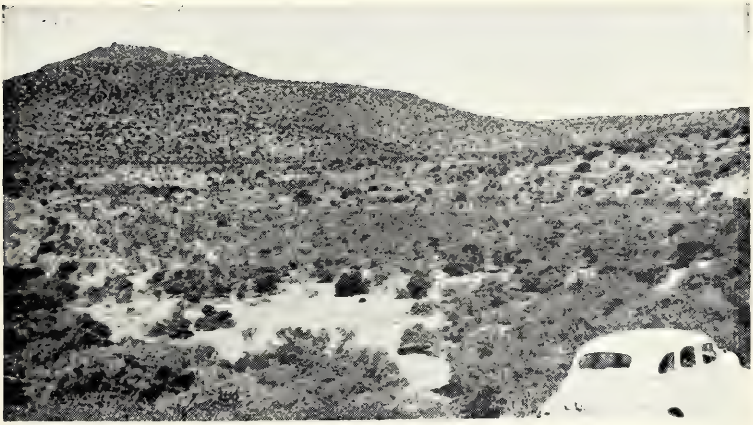


Fig. 17—Shortcomings of Chart MET 20.

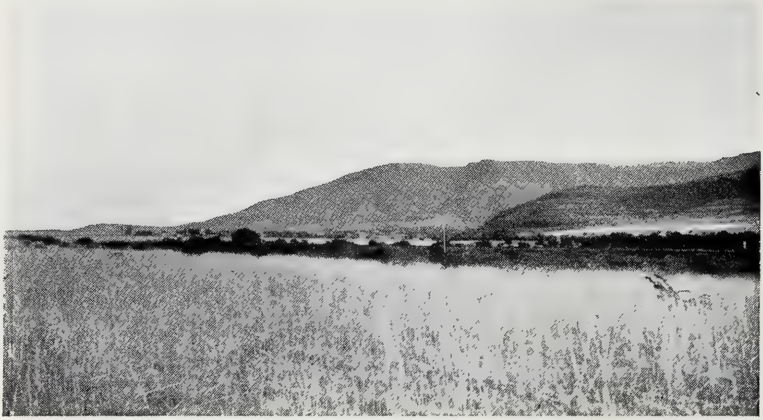
A. Starting time covered by end of chart
B. Chart lifted to expose starting time
C. Pen raised off drum at the end of the week
c. clip
d. chart
p. pen.



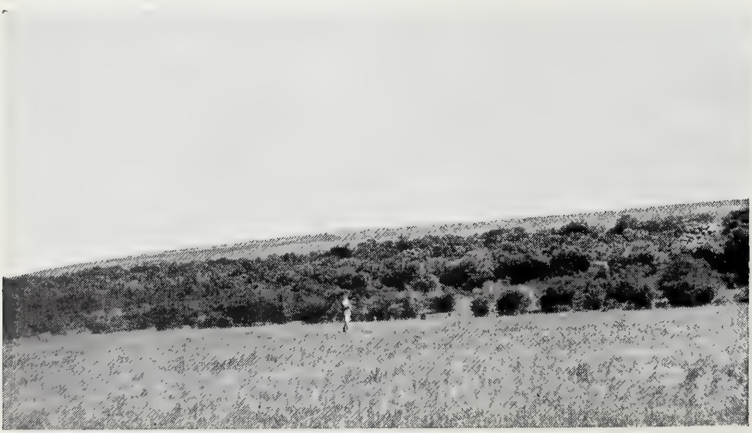
1. Acacia encroachment on land formerly clear. District Adelaide, 25 Oct 49.



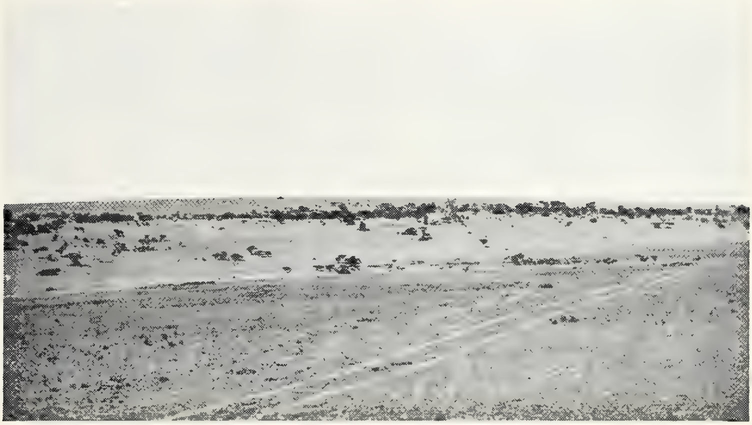
2. Acacia in the Baviaans River valley. 35·3 miles from the Bedford war memorial on the road to Tarkastad, 13 Apr 51.



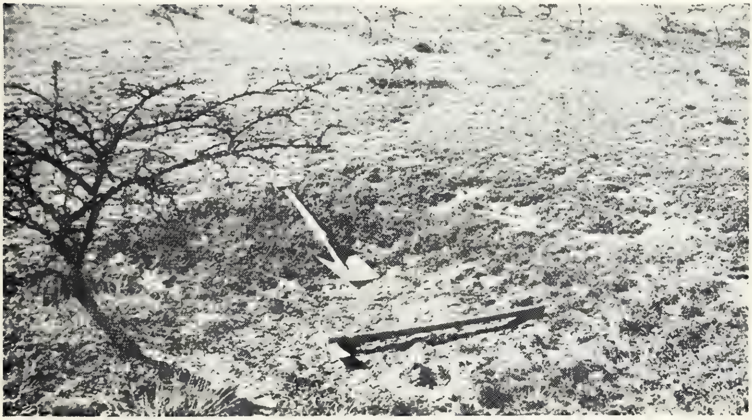
3. Grass on undisturbed soil in foreground, Acacia on disturbed soil in background. 500 yards east of the railway crossing on the eastern outskirts of Bedford, 13 Apr 51.



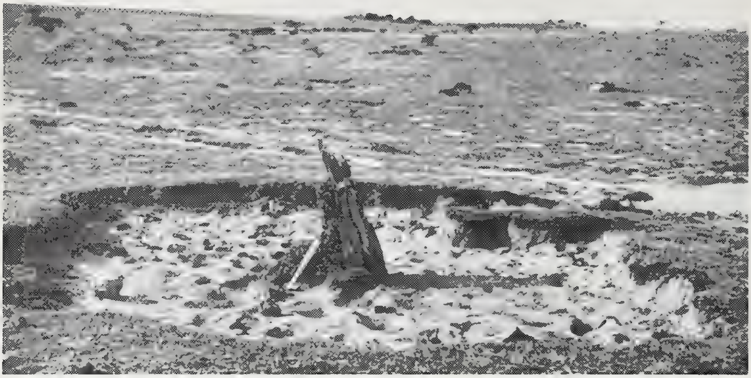
4. Mixed bush on south slopes of Round Hill. District Bathurst, 6 Apr 50.



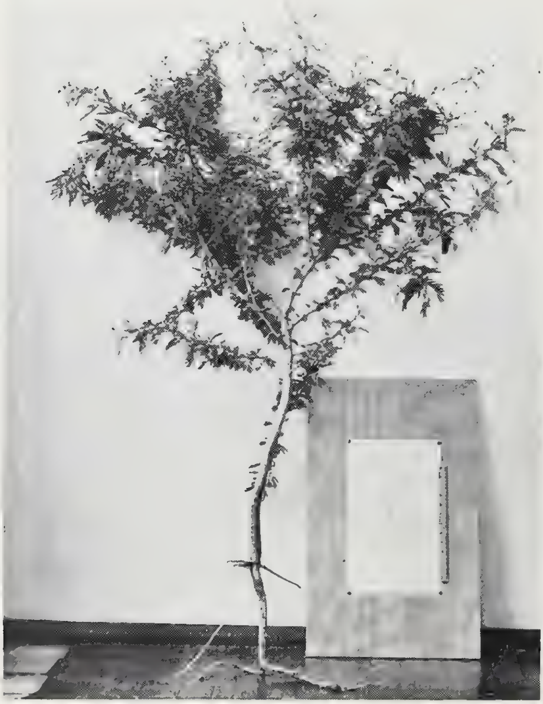
5. Acacia scrub on north slopes of Round Hill. District Bathurst 6, Apr 50.



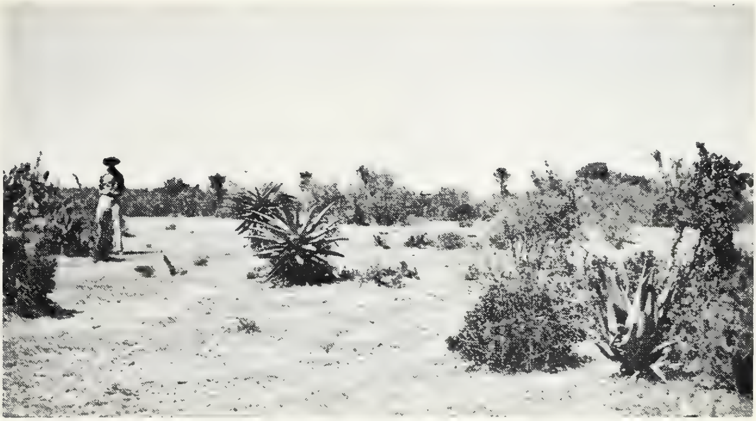
6. Hollow left after death of Acacia tree. Grahamstown commonage, 8 Aug 47.



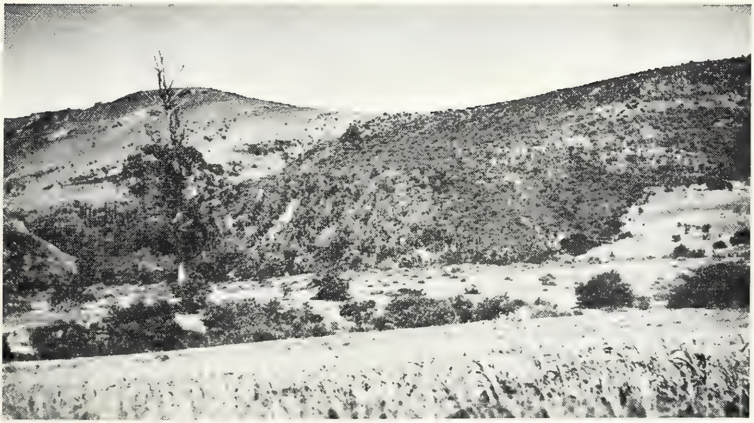
7. Hollow left after death of Acacia tree. Grahamstown commonage, 8 Aug 47.



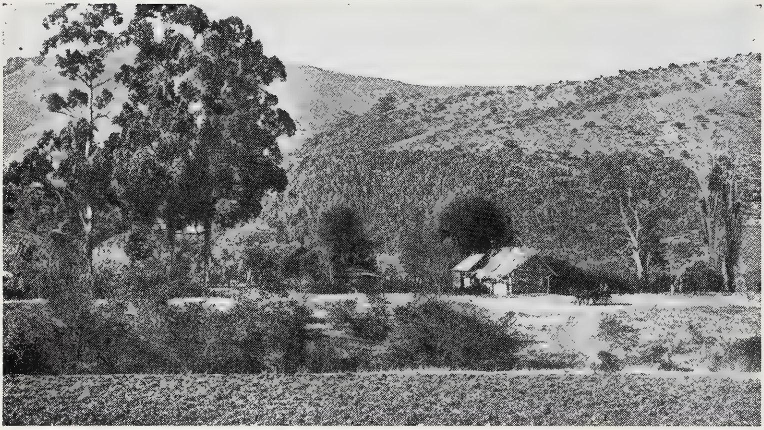
8. Large Acacia (age 2 years 4 months) grown in cultivated ground, small one (3 weeks younger) in adjacent grassland.



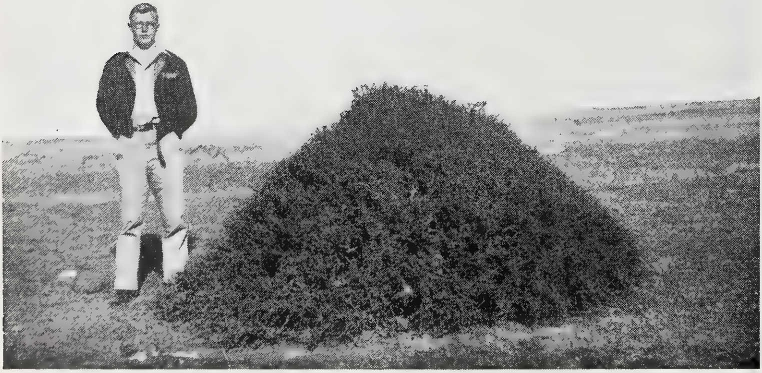
9. Woodland type 2. About 200 yards east of the memorial stone, Fort Cox, 19 Jan 50.



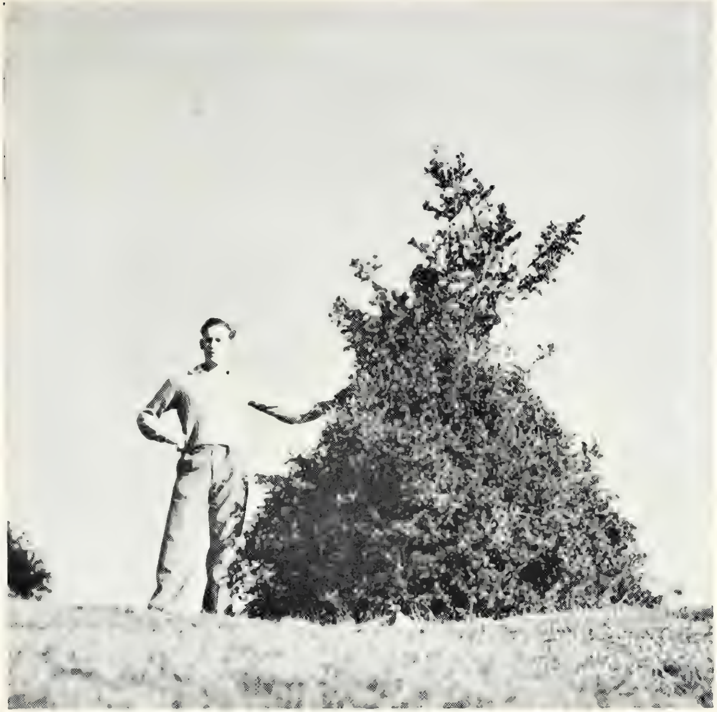
10. Mixed scrub on hillside. On road to Chatha Forest Station, 24 Jan. 48.



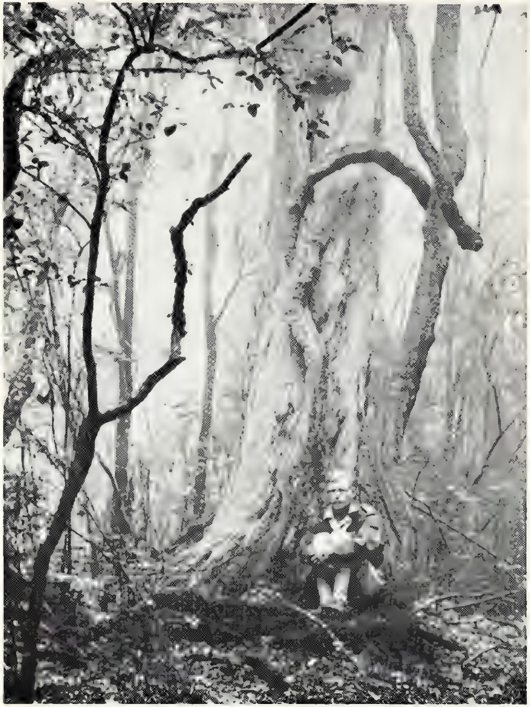
11. Former appearance of the hillside shown in photograph 10, about 1912. Photo W. M. Spring.



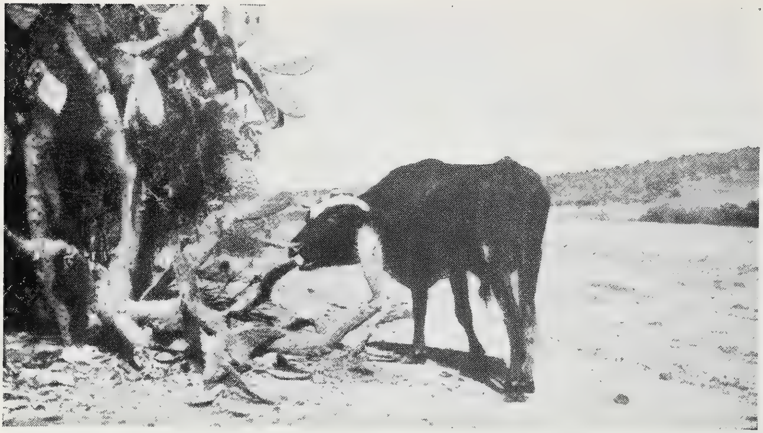
12. Cone shape caused by browsing *Randia rudis*. ½ mile from the road between Breakfast Vlei and Debe Nek, on the road to Middledrift, 9 Oct 48.



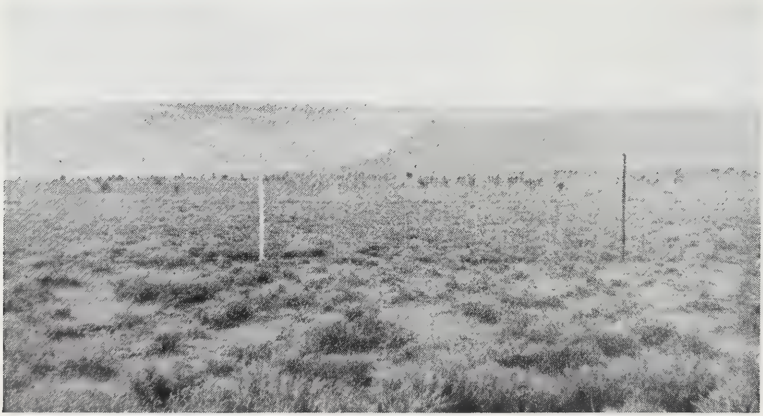
13. Hour-glass shape caused by browsing taller trees. The example shown is *Scutia myrtina*. 50 yards from beacon Zanyokwe 97 at a bearing of 30 magnetic, 15 Jul 49.



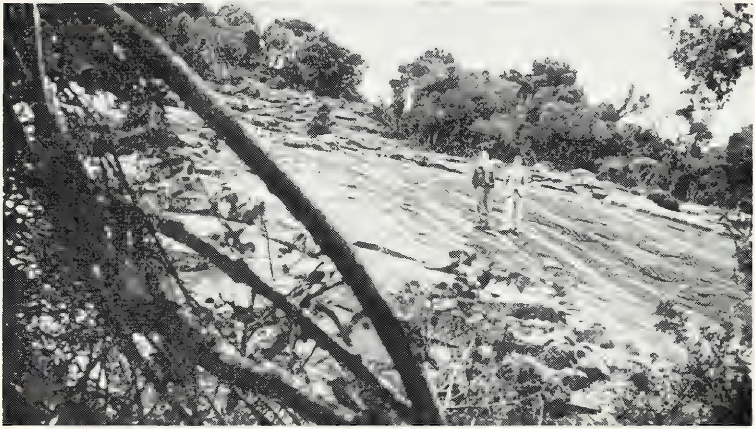
14. Habit of *Scutia myrtina* in forest. Chatha Forest Station, 26 Jan 50.



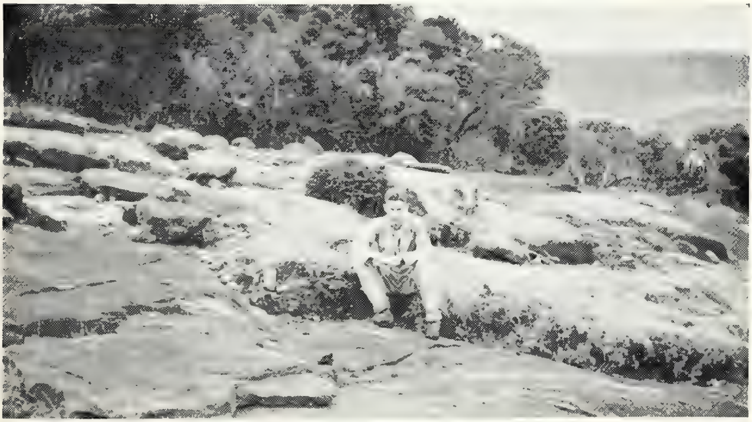
15. Opuntia being eaten during drought. 100 yards south of bridge over the Keiskamma River on the road from Keiskammahoek to Fort Cox, 21 Sep 49.



16. Destruction of karroid scrub by heavy stocking. District Uitenhage, 17 Apr 47.



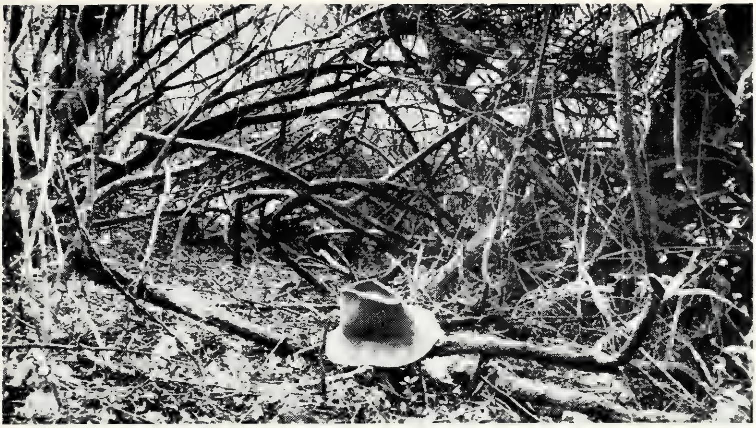
17. Erosion of thin soil over dolerite, woodland type 3. Nqhumeya Ridge, 21 Jan. 50.



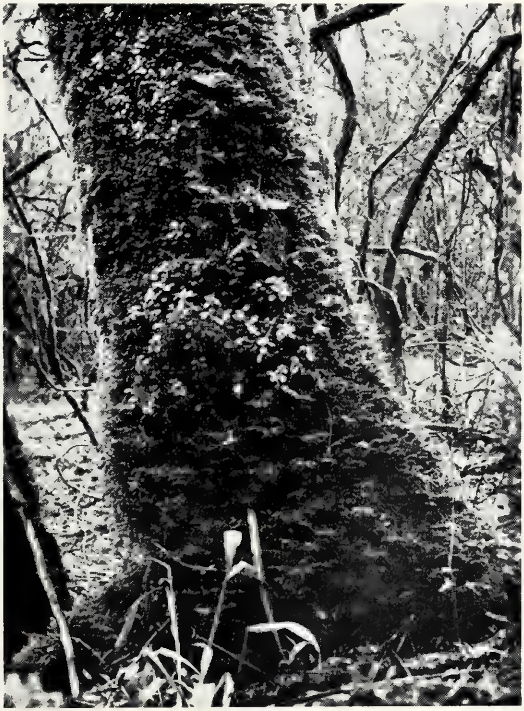
18. Erosion of thin soil over dolerite, woodland type 3. Nqhumeya Ridge, 21 Jan 50.

19. Bare dolerite hill. Nqhumeya Ridge. 14 Dec 50.

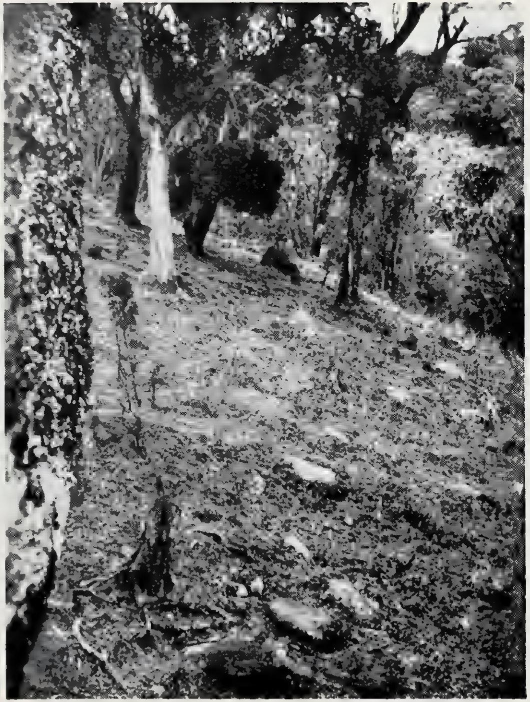
20. Denudation, woodland type 3. 200 yards south of the commonage boundary on the road from Keiskammahoek to Nqhumeya. 22 Sep 49



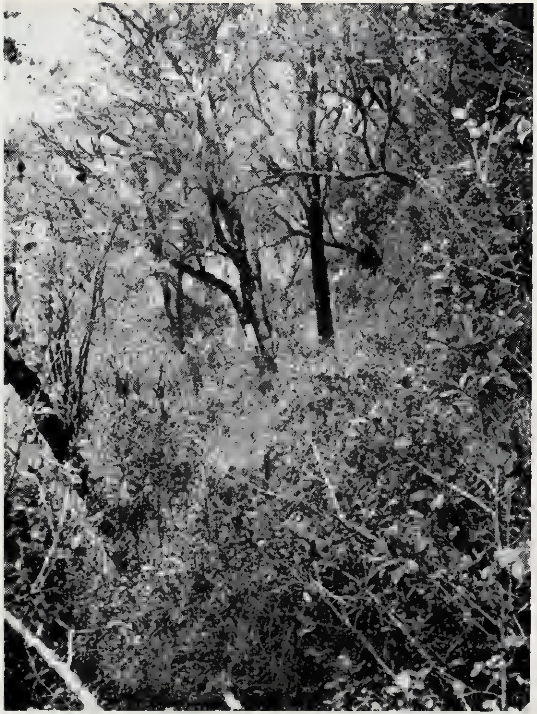
21. Litter on forest floor under lianes. Note absence of undergrowth and young trees. Woodland type 5, Lenye Forest Station, 23 Sep 49.



22. Epiphytes, woodland type 5. The grass is *Panicum maximum*. 23 Sep 49.



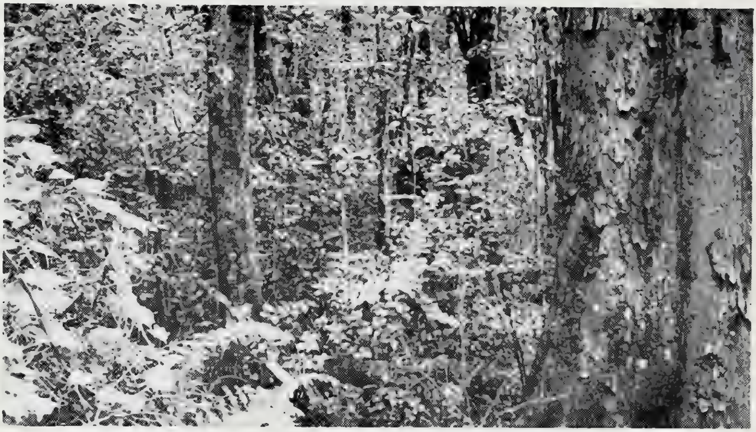
23. Unprotected forest, woodland type 5, showing lack of undergrowth and *Cynodon dactylon* in its place. Ingwe forest, about 2⅛ miles south of the homestead, Chatha Forest Station, 27 Oct 49.



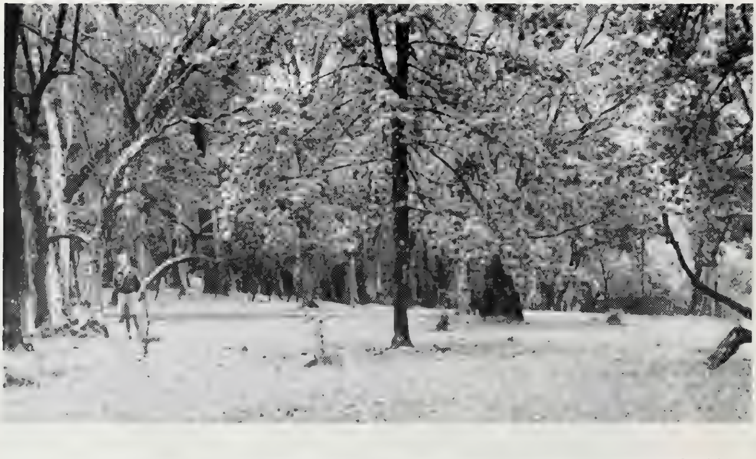
24. Protected forest, woodland type 5, showing dense undergrowth. About 2 miles south of the homestead, Chatha Forest Station, 27 Oct 49.

25. General destruction in unprotected forest, woodland type 5. As for photograph 23.

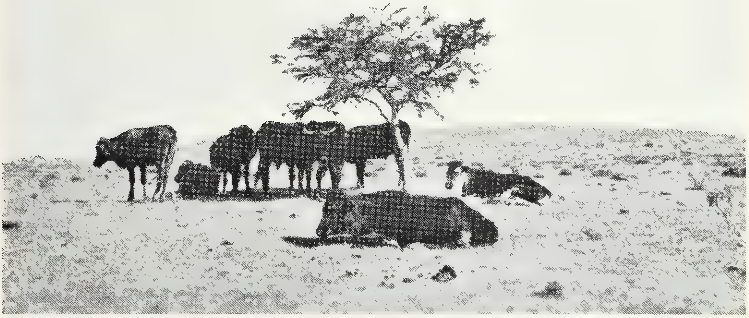
26. Unbroken cover in protected forest, woodland type 5. As for photograph 24.



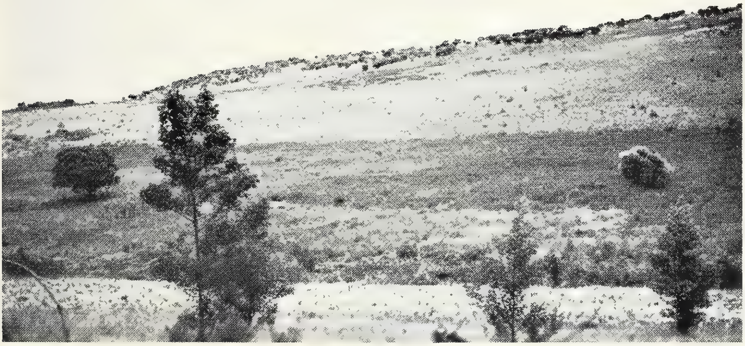
27. Protected forest, woodland type 6. Wolf Ridge Forests, 24 Jan 50.



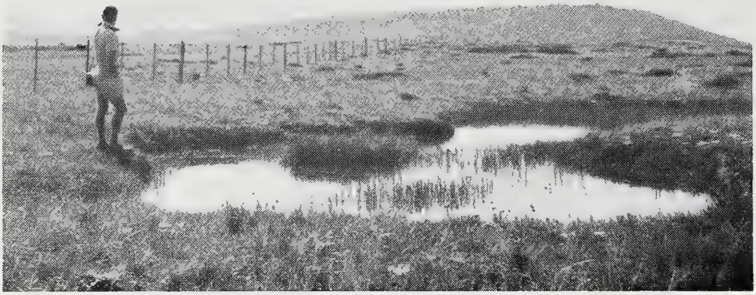
28. Unprotected forest, woodland type 6. ½ mile from the road between Wolf Ridge and Keiskammahoek, on the track going south along the ridge which runs towards Mount McDonald, 24 Jan 50.



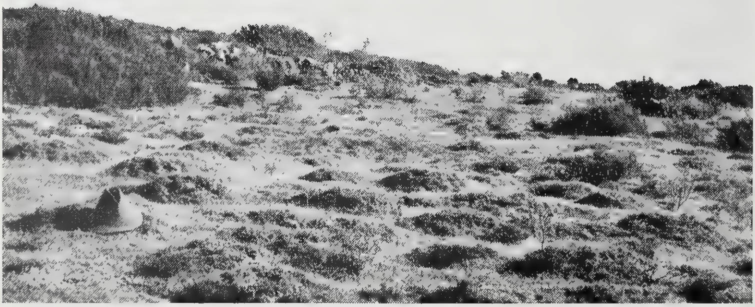
29. Isolated trees do not act as pioneers if the stocking is heavy. Plateau above Lenye Forest Station, about 300 yards south of Forestry Department beacon 126, 20 Jan 49.



30. Macchia on old fallow land. Collingham Tower, district Albany, 5 Feb 48.

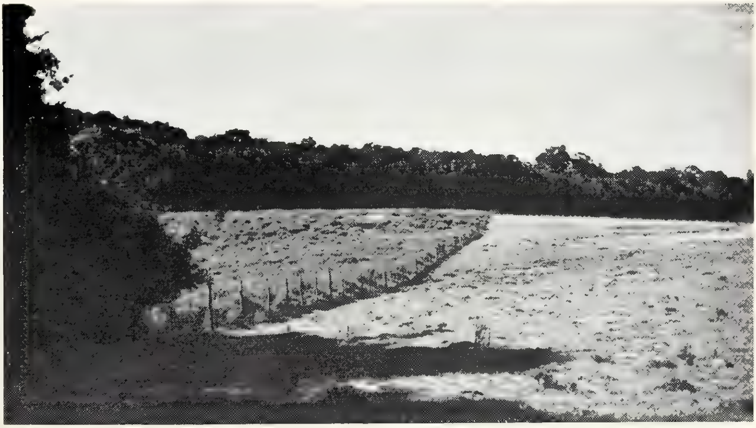


31. Water held in Debe hollows after rain. Plateau above Debe Nek, 5 May 48.

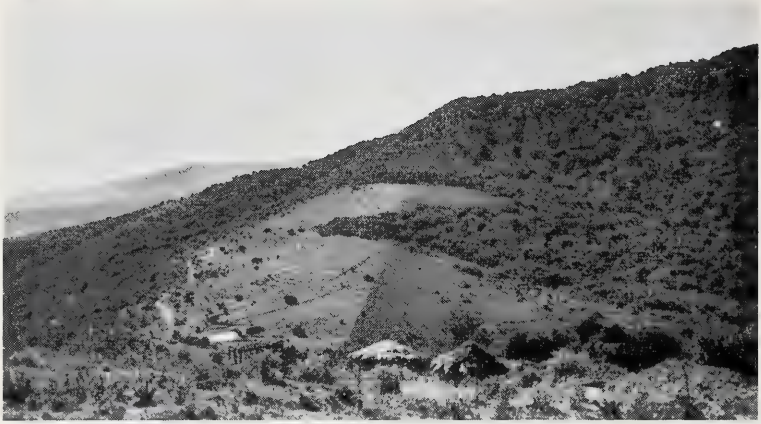


32. Molehills in the sourveld. Wolf Ridge, 18 Aug 49.

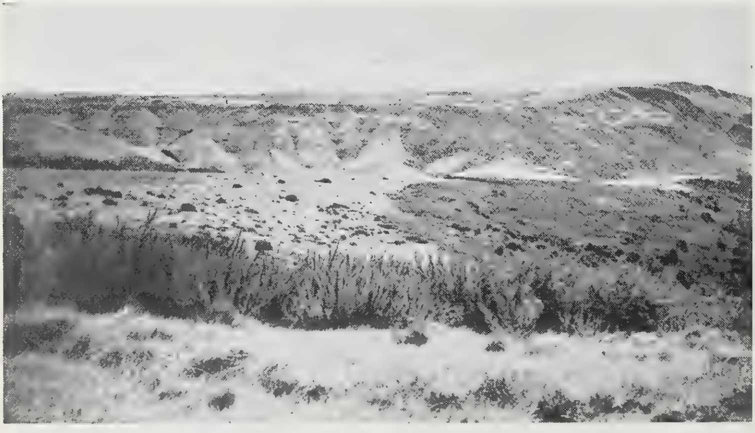
33. Fallow lands under grass with surrounding macchia of *Cliffortia linearifolia*. ½ mile east of woodcutter Flanagan's homestead, plateau above Debe Nek, 31 Aug 50.



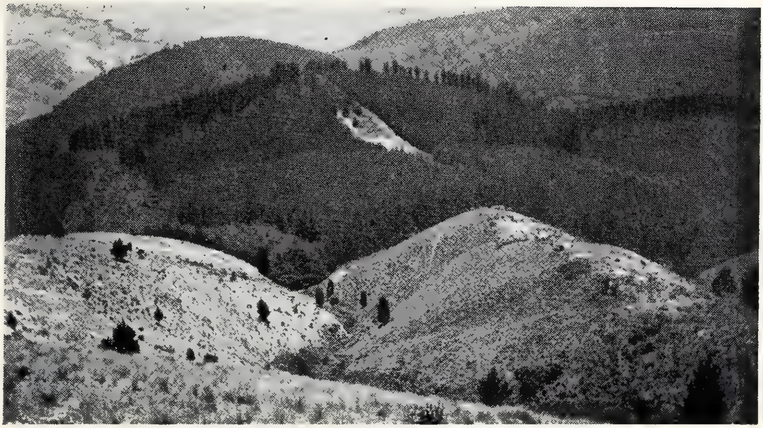
34. Suppression of macchia (*Cliffortia linearifolia*) by heavy grazing on right of fence. Fence erected 1936. 15 yards east of Forest Department beacon 126, 20 Apr 49.



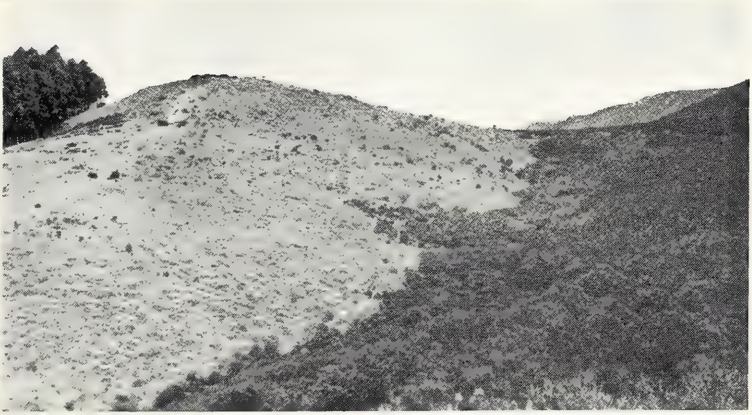
35. Forest Department ground on right of fence, heavily-grazed commonage on left with macchia (*Cliffortia linearifolia*) suppressed. South-west slopes of Charybdis, 3 May 49.



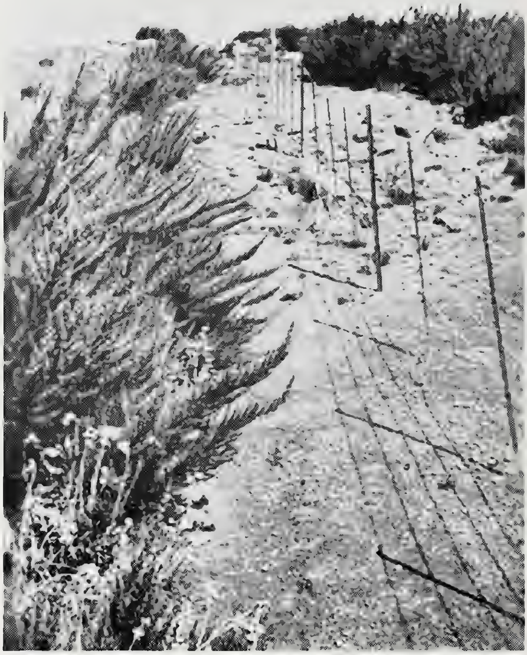
36. Forest Department land in the Kaga Mountains, Bedford district, with macchia of *Cliffortia paucistaminea*. 18 May 50.



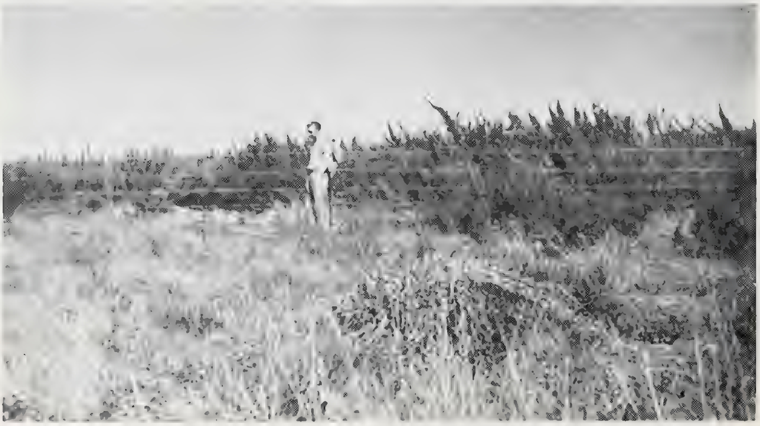
37. Early stage in the destruction of sourveld. The slope breaking down more rapidly is the xerocline. Chatha East ministerial grazing, 12–13 Feb 48.



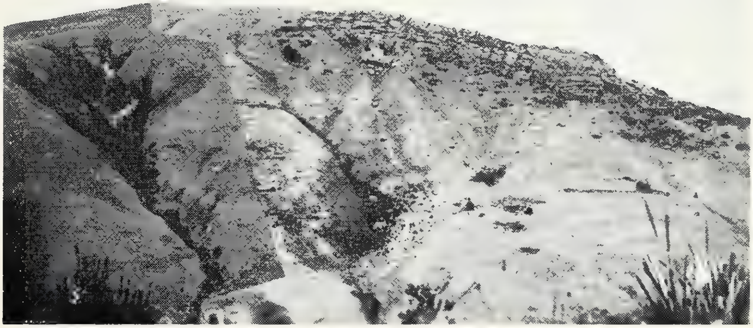
38. Late stage in the destruction of sourveld. *Helichrysum argyrophyllum* on the xerocline, macchia on the mesocline. Chatha East ministerial grazing, 12–13 Feb 48.



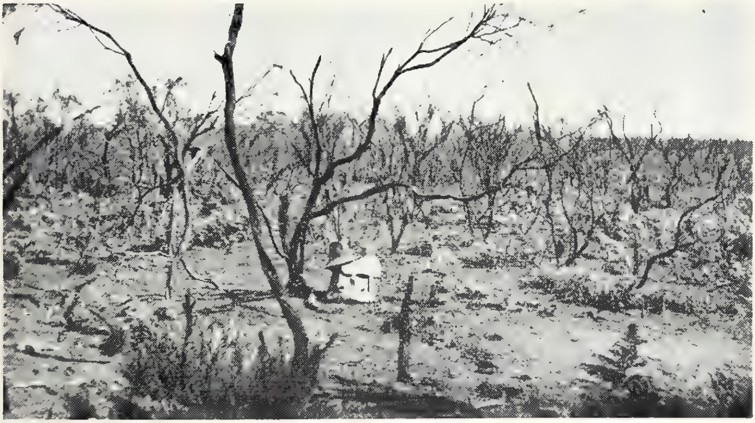
39. Area on right selectively grazed, causing bare ground and invasion by macchia (*Cliffortia paucistaminea*). Ground on left protected and clear of macchia except along the firebreak where there is no grass competition. Evelyn Valley Forest Station, about 1½ miles from the homestead on the way to trig beacon 91 West Peak Pirie, 25 Jan 49.



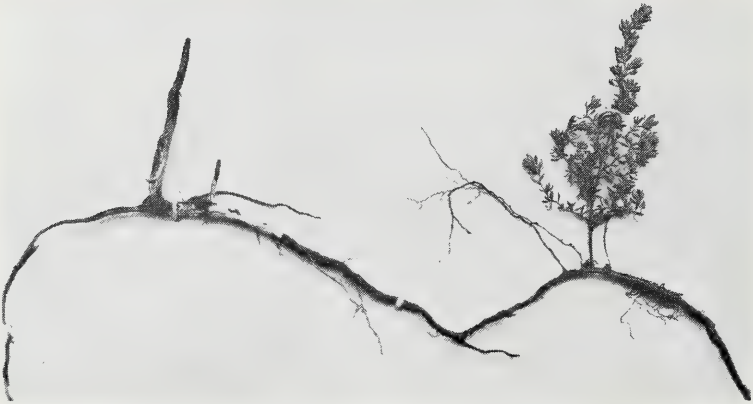
40. Foreground protected and almost clear of macchia, background selectively grazed and under dense *Cliffortia paucistaminea*. As for photograph 39, 4 May 49.



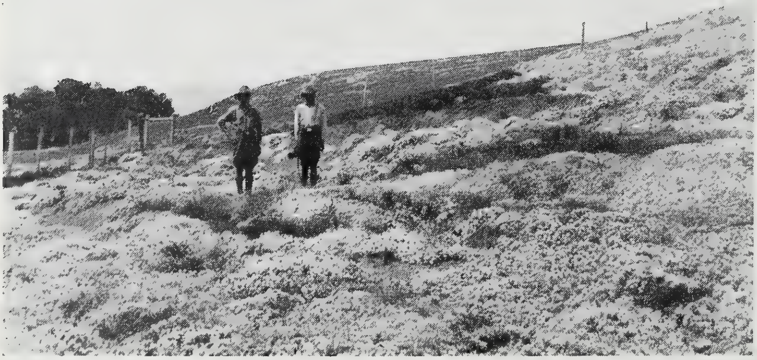
41. Invasion by *Helichrysum argyrophyllum* on over-grazed land to the right of the fence. Note macchia along watercourses and below cliffs, where run-off from rocks causes moister soil. Taken from Chatha East ministerial grazing, looking south-east towards point 5387, 12–13 Feb 48.



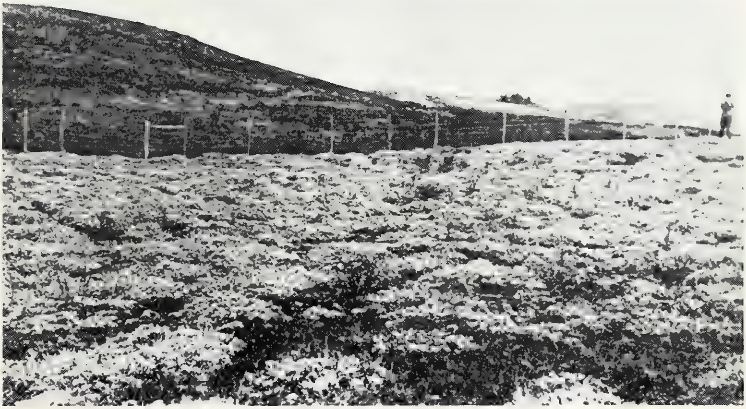
42. Dense macchia after a fire. Plateau west of West Peak Pirie, 21 Apr 49.



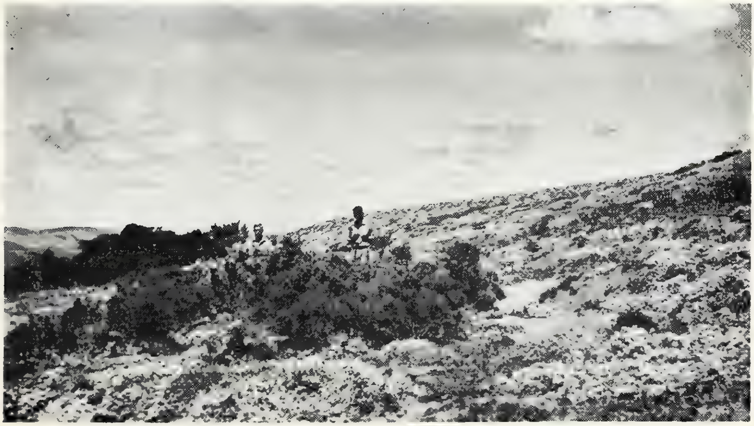
43. Sucker developing from *Cliffortia paucistaminea* after death by burning of the main stem on the left.



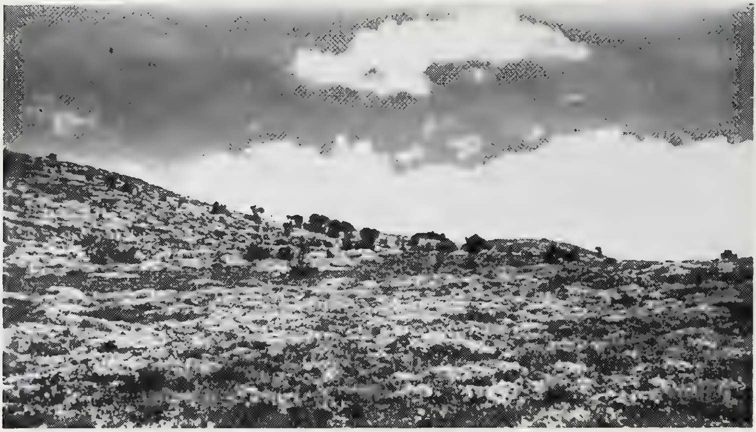
44. Schonland's plot in the early 1920's. Note the absence of macchia. Photograph by R. A. Dyer.



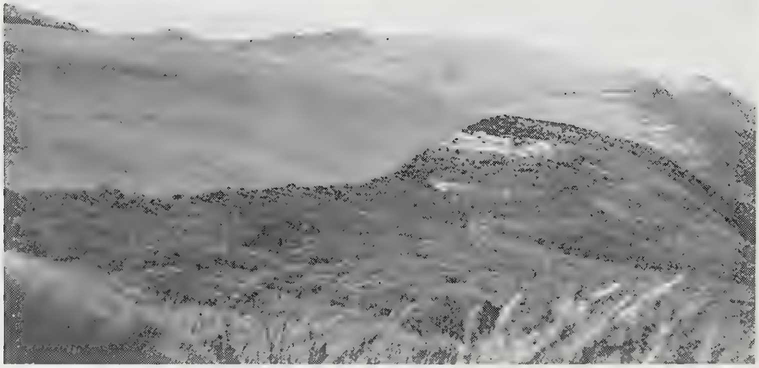
45. Schonland's plot in the early 1920's. Note the absence of macchia. Photograph by R. A. Dyer.



46. Schonland's plot 18 Feb 49. Note presence of macchia.



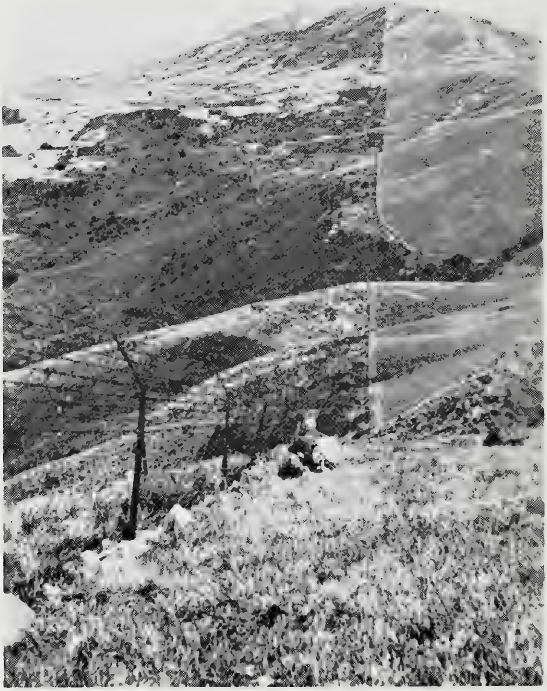
47. Schonland's plot 18 Feb 49. Note presence of macchia.



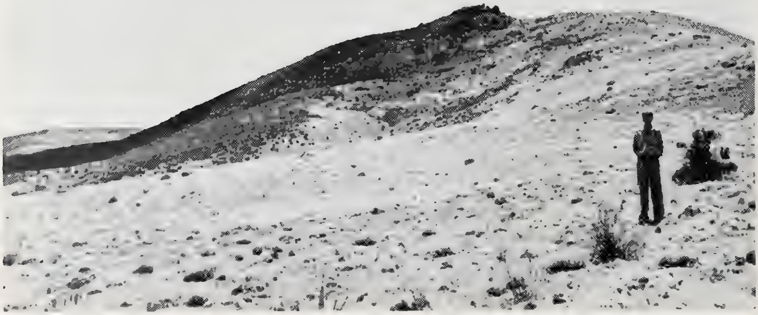
48. Suppression of macchia (*Erica brownleeae* and *Cliffortia paucistaminea*) on the left of the fence by burning, probably with controlled grazing. Land on right of the fence grazed without system. 200 yards south-east of Chatha beacon (point 5387), looking east, 12 Aug 49.

49. A similar relation to the one shown in photograph 48, with macchia of Protea, Erica and Cliffortia. About 2 miles west of Mount Thomas beacon, 10 Nov 48.

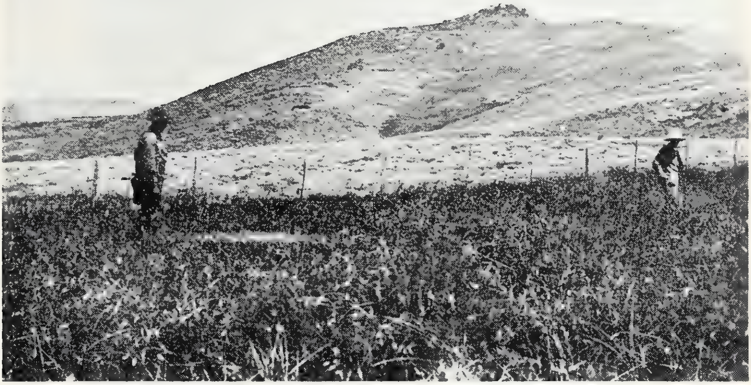
50. About 1 mile west of Mount Thomas beacon, looking west. Photograph by A. E. Sonntag, about 1942.



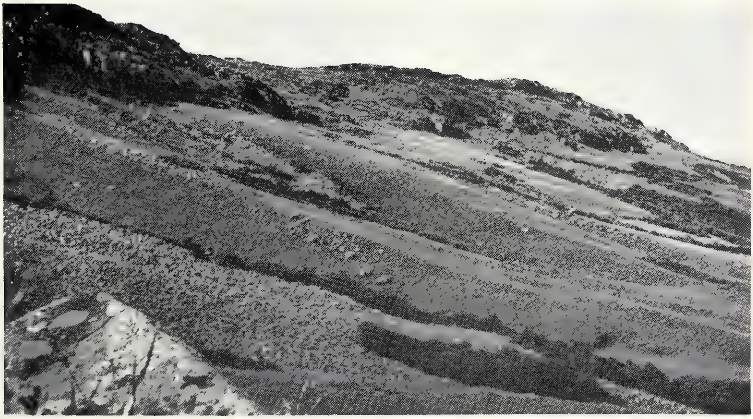
51. From the same position as that of photograph 50, 11 Nov 48. Note slow increase of macchia.



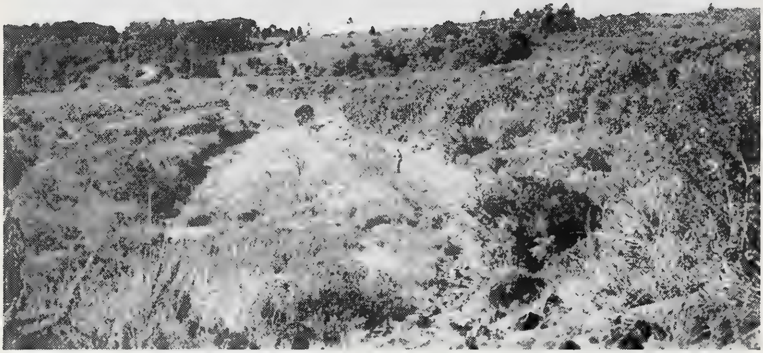
52. Looking west from Schonland's plot, 18 Feb 49. Compare photograph 53 and note increase of macchia in background.



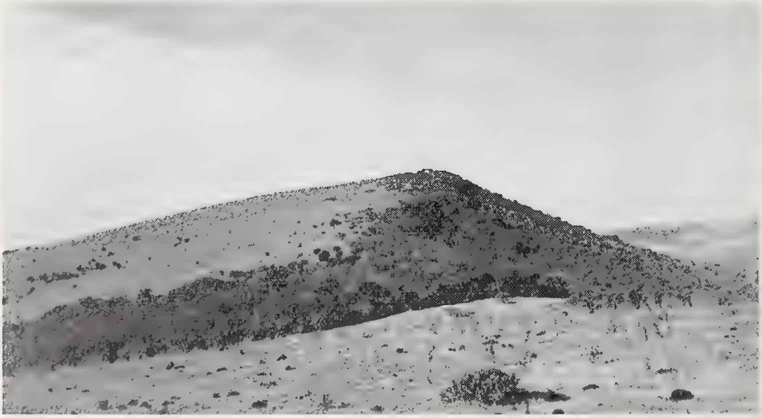
53. Looking west from Schonland's plot in the early 1920's. Photograph by R. A. Dyer.



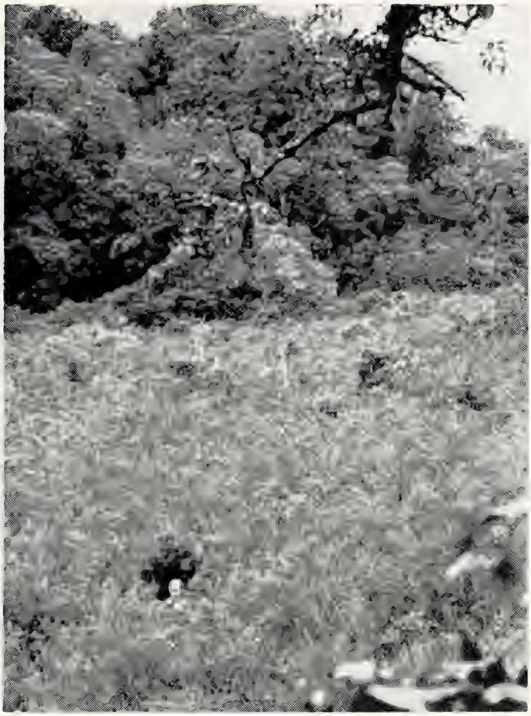
54. Postclimax bush fringing scree. Elandsberg, on the farm Coolin, 23 Apr 49.



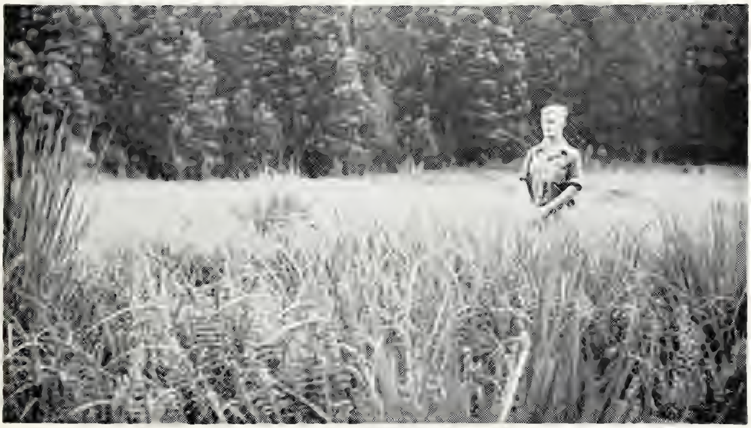
55. Grassy firebreaks in dense macchia. About a mile south of the homestead, Evelyn Valley Forest Station, 4 May 49.



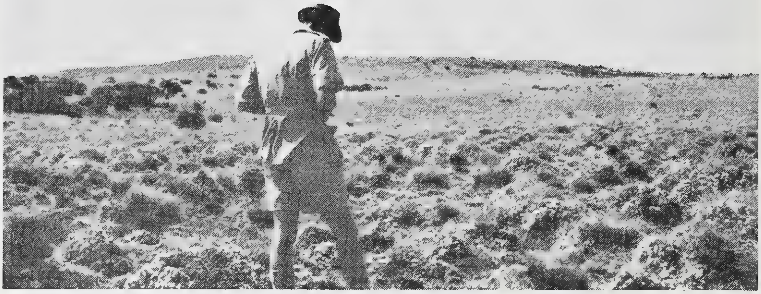
56. Forest on slopes and in dips, Passerina along the escarpment. About ¾ mile west of trig beacon Zanyokwe 97, looking east, 15 Jul 49.



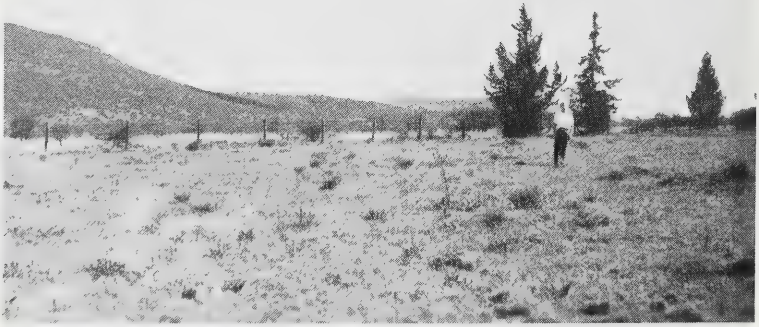
57. *Cliffortia serpyllifolia* covering marshy area in protected forest. Wolf Ridge forests, 24 Jan 50.



58. Sedges, ferns and grasses covering protected marshy ground above the forests. Hunterstoun, Hogsback, 26 Jan 50.



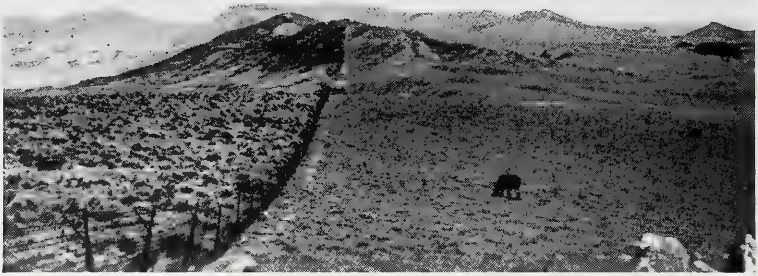
59. Sedge and Helichrysum covering overgrazed marshy ground. Wolf Plateau, 10 Sep 47.



60. Protected sweetveld pasture. Cemetery, Keiskammahoek, 17 Nov 48.

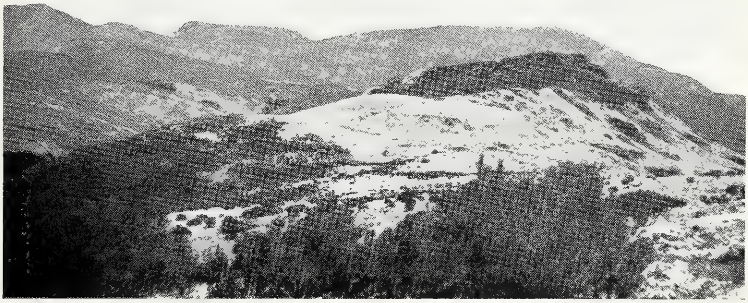
61. *Ornithogalum thyrsoides* in overgrazed veld. About 300 yards east of the cemetery, Keiskammahoek, 17 Nov 48. Compare photograph 60.

62. *Bulbine asphodeloides* formerly dominant near the Magistrate's Court, Keiskammahoek. Photograph R. A. Dyer, March 1928.

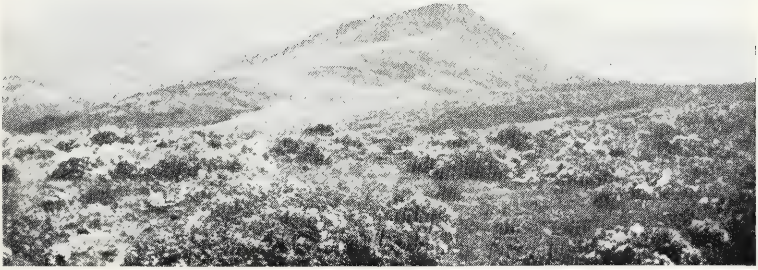


63. On the left of the fence selective grazing and no burning have encouraged the growth of tufts of unpalatable grass—probably *Aristida galpinii*. About ½ mile west of Mount Thomas beacon, 11 Nov 48.

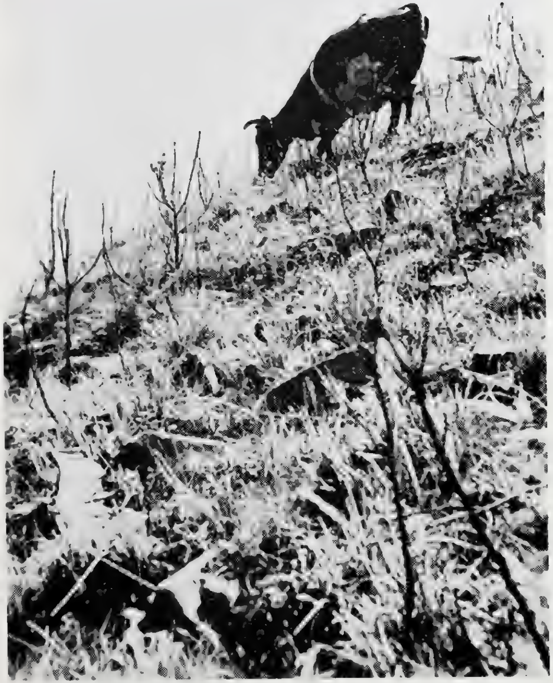
64. Sourveld pasture. Summit of the Elandsberg, farm Coolin, 23 Apr 49.



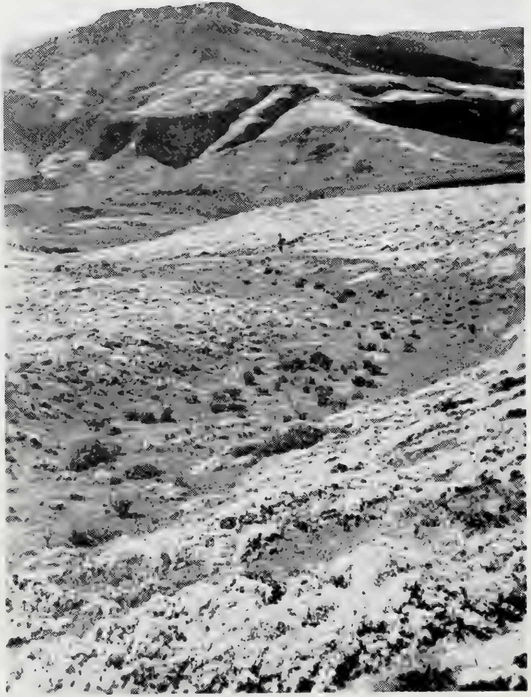
65. Helichrysum encroachment. Looking north from about ½ mile north of point 4329, Gxulu commonage, 3 Dec 48.



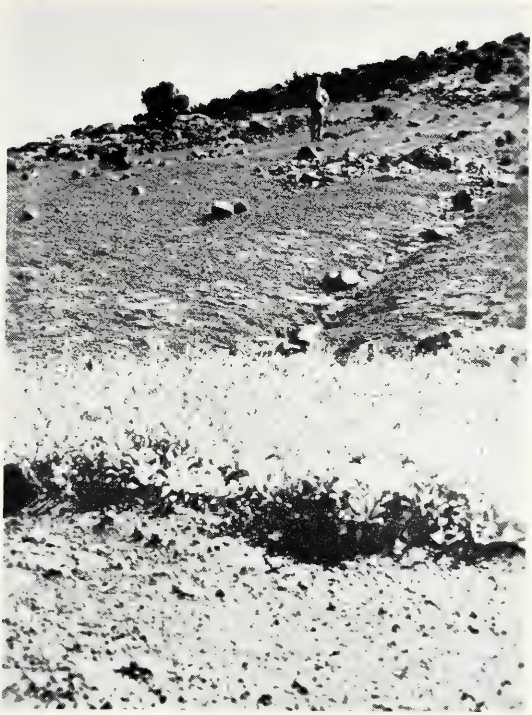
66. Compare photograph 65. Taken from the same position in the early 1920's. Photograph E. D. Beale.



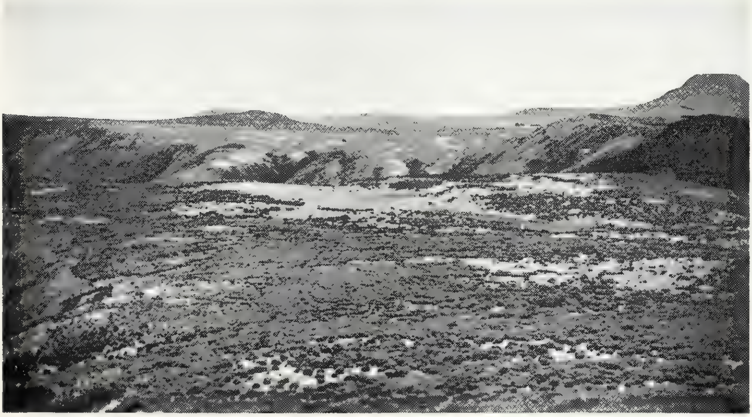
67. Cow grazing a 38° slope. Chatha East ministerial grazing 31 Dec 48.



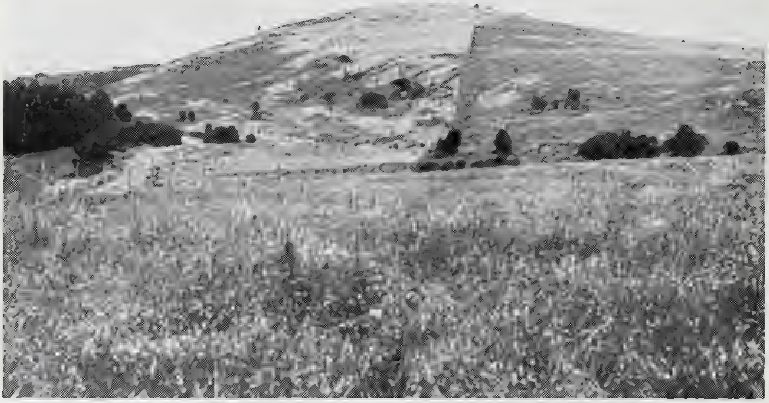
68. Persistence of grass cover and consequent exclusion of Helichrysum in moist depression. About 1 mile west of Schonland's plot, 18 Feb 49.



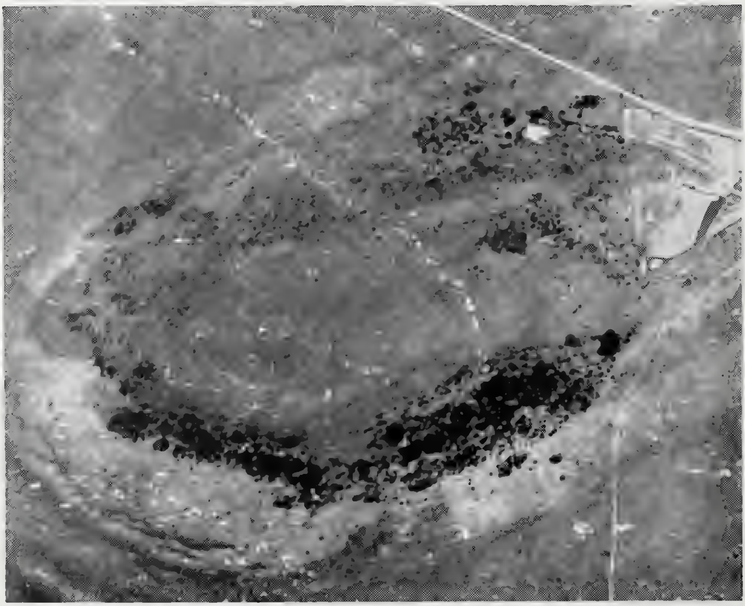
69. Absence of Helichrysum in very heavily trampled area. South-east edge of Wolf Plateau, 24 Mar 48.



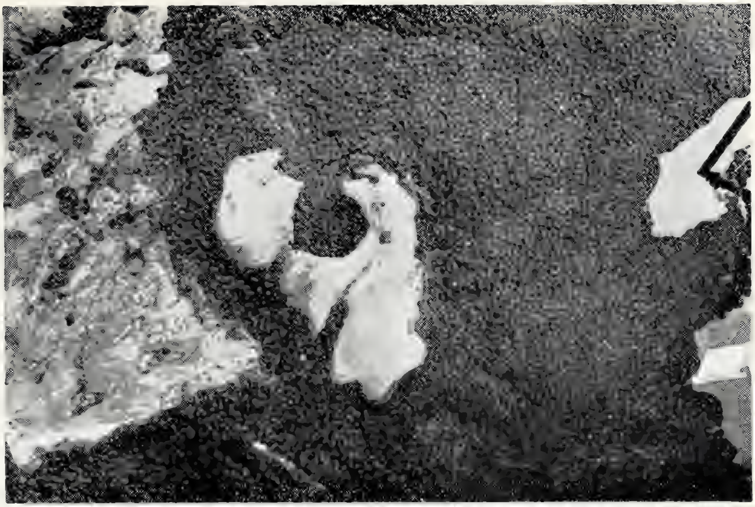
70. Invasion of Helichrysum by macchia. Plateau north-west of Geju mountain, 26 Jan 48.



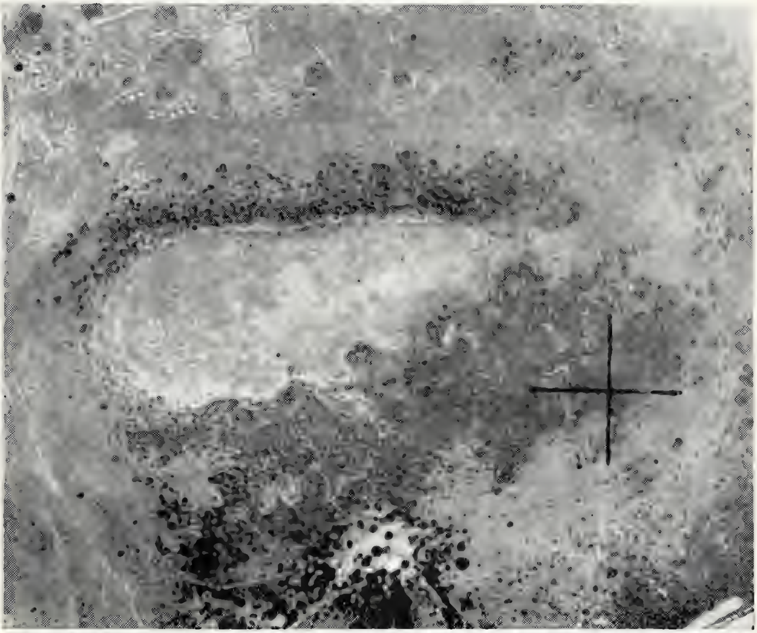
71. Restoration of grass cover by burning Helichrysum before spring rains. King's Nek, 1950. Photograph R. L. Robb.



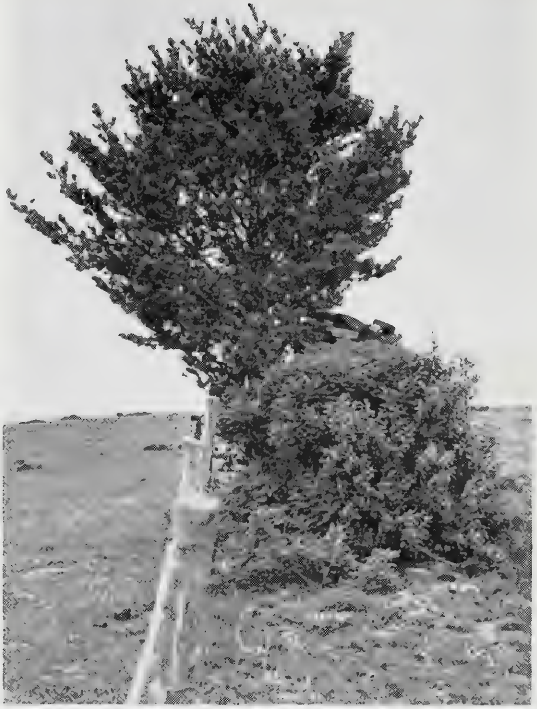
72. Unbroken ring of woodland on slopes of Round Hill, district Bathurst. Mixed bush on mesocline, Acacia on xerocline. Job 3/42, strip 22, photograph 05801, reproduced under Govt. Printer's Copyright Authority No. 920 of 5/2/51.



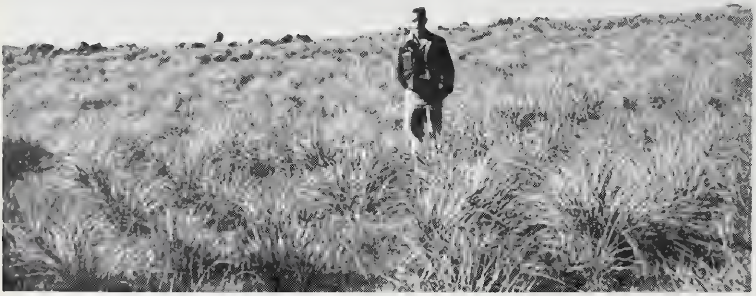
73. Island of grass on level ground, surrounded by forest on sloping ground. Windy Peak, about 2 miles south of Evelyn Valley Forest Station. Job 134/38, strip 44, photograph 10503, reproduced under Govt. Printer's Copyright Authority No. 920 of 5/2/51.



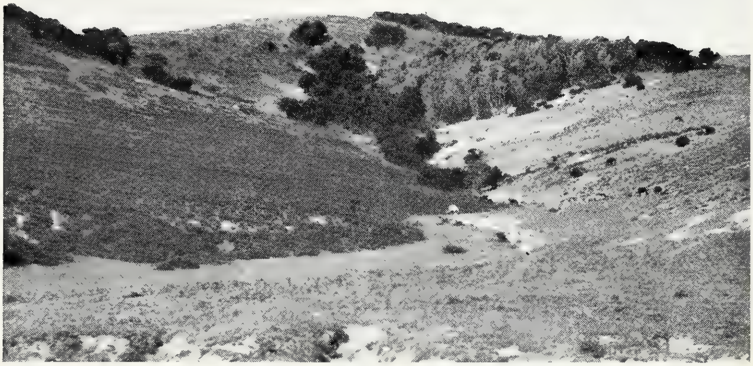
74. Hill about 2 miles north of St. Matthews Mission Station. Note absence of trees on the plateau and on the two ridges leading up to it. Job 134/38, strip 37, photograph 10236, reproduced under Govt. Printer's Copyright Authority No. 920 of 5/2/51.



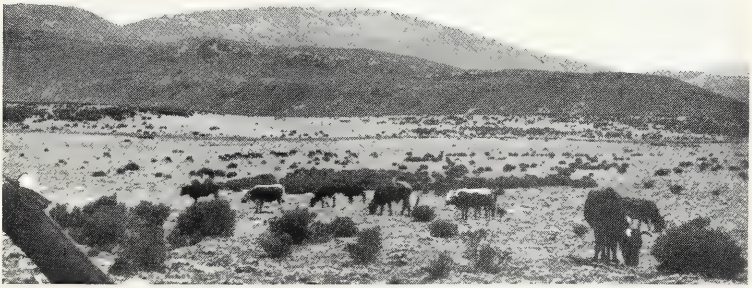
75. Cairn providing shelter for forest seedlings. The following species were present: *Calpurnia sylvatica, Canthium ciliatum, Clausena inaequalis, Euclea* sp., *Gymnosporia buxifolia, Halleria lucida, Podocarpus latifolius, Rapanea melanophloeos, Rhamnus prinoides, Rhoicissus cuneifolia, Rhus legati, Vepris lanceolata.* Forest Department beacon 48, on the ridge running from the Wolf Ridge forests towards Mount McDonald, 24 Jan 50.



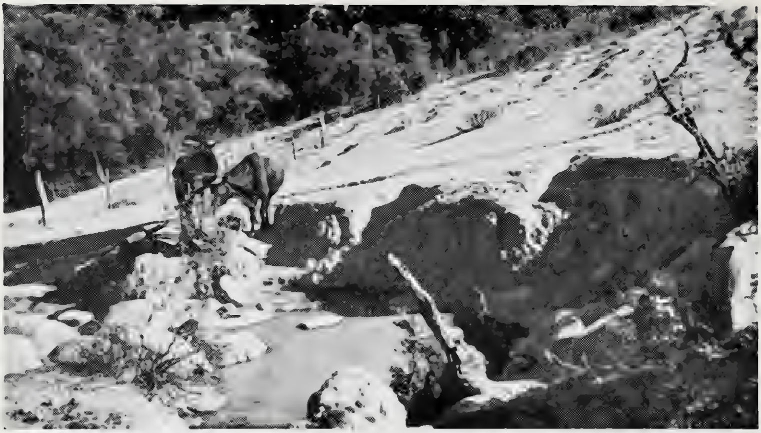
76. *Festuca costata* grasslands about 2 miles east of Gaika's Kop. 26 Jan 50.



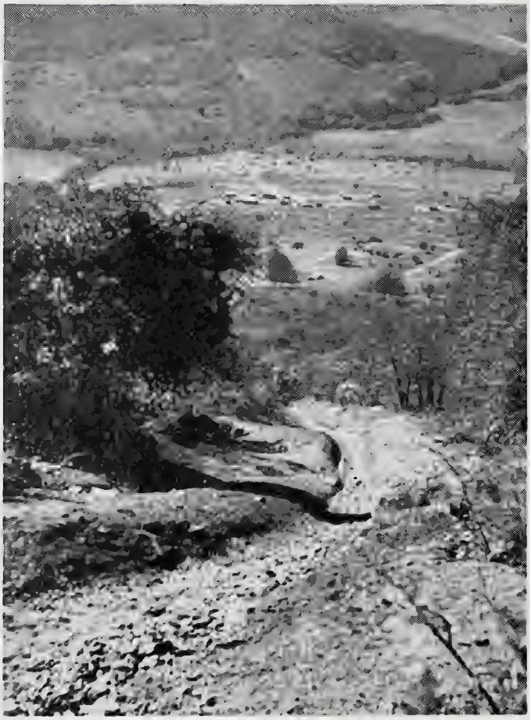
77. Macchia (*Cliffortia linearifolia*) on the mesocline, grass on the xerocline. 300 yards north of the homestead, Rabula Forest Station, 12 Oct 50.



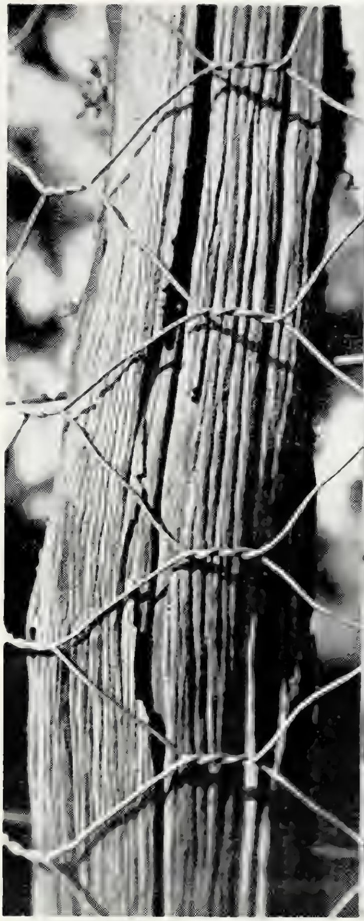
78. Wolf Plateau, showing dominance of Helichrysum on level ground and of macchia on the slopes. 20 Jan 51.

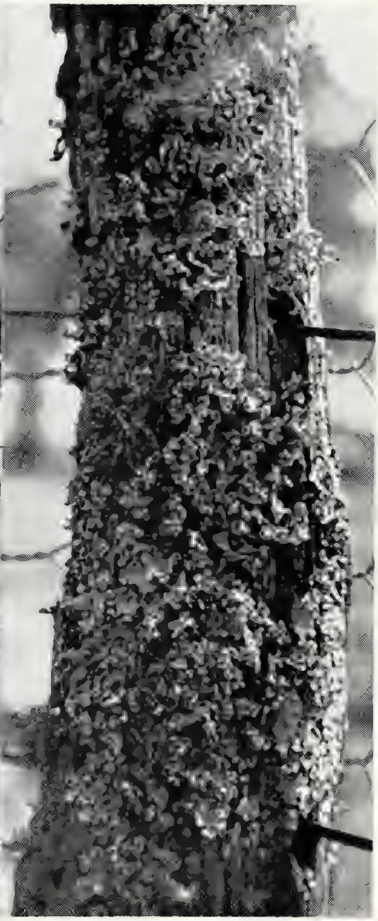


79. Spring trampled by cattle. Ridge between Gwili-gwili and Dontsa, 14 Jul 49.



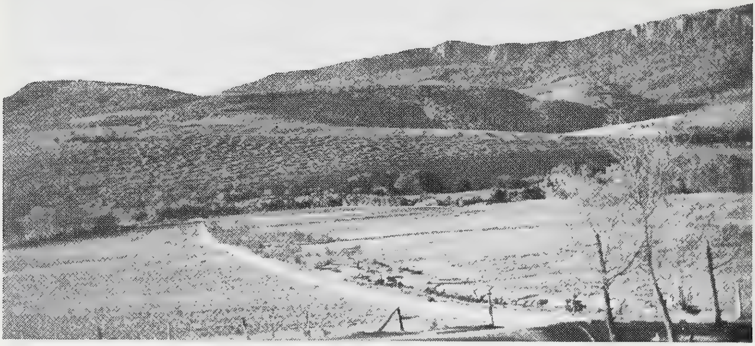
80. Channel caused by dragging timber from plantations. Lenye Forest Station, 20 Apr 49.



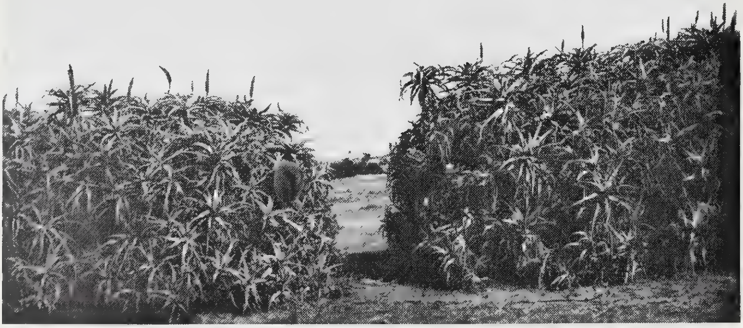


81. (Left) Northern side of sneezewood pole. Keiskammahoek cemetery, 13 Oct 50.

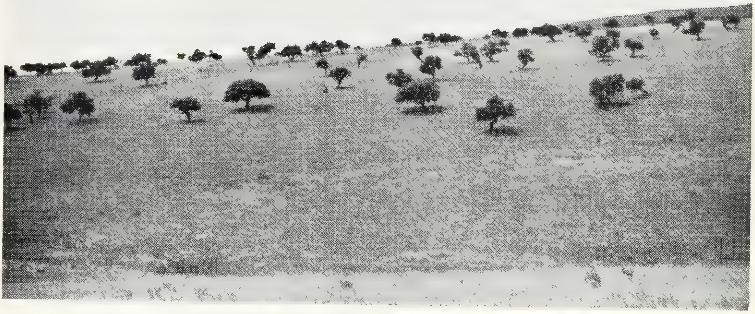
82. (Right) Southern side of the pole shown in Photograph 81, showing thick lichen growth, 13 Oct 50.



83. Debe hollows. 0·8 mile from Rabula bridge on the road between Keiskammahoek and Debe Nek, 16/7/49.



84. Hedge of *Aloe arborescens.* About 5 miles from Middledrift on the road to Amatole Basin, 19 Apr 49.



85. Open woodland of *Protea multibracteata*. ¾ mile east of the divisional boundary on the road between Keiskammahoek and Stutterheim, 17 Apr 51.

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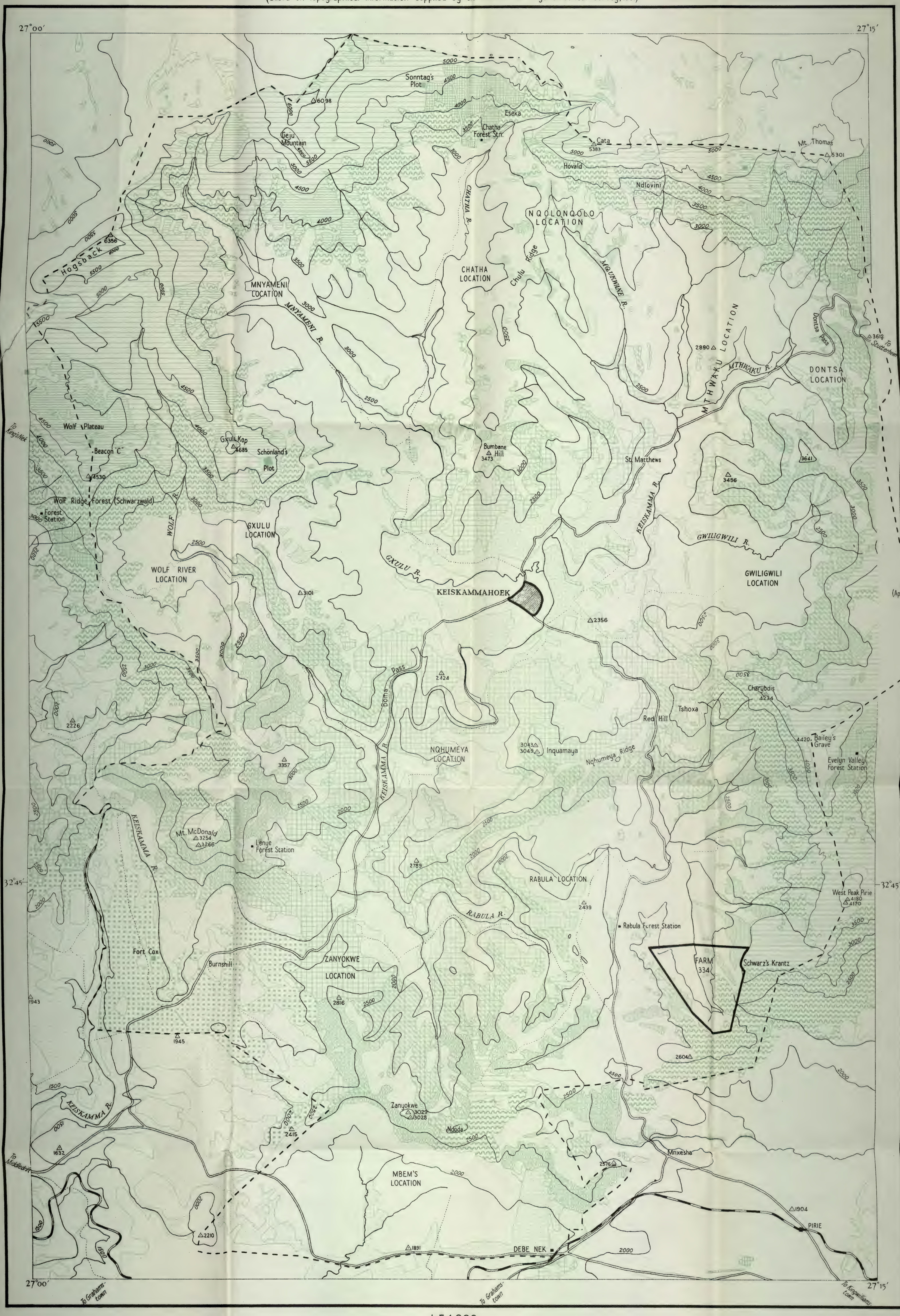
VEGETATION OF KEISKAMMAHOEK

AS IN JUNE 1948

(Based on Topographical Information supplied by the Director of Trigonometrical Survey, 1951)



1:54,000

YARDS 1500 0 1500 3000 4500 6000 7500 9000 YARDS

Scale : 1500 Yards = 1 Inch

AREA OF DISTRICT - 68924 Morgen, made up as follows :—

Open Woodland, 2911 Morgen	▨
Woodland Type 1 - Acacia Scrub, 2612 Morgen	▨
Woodland Type 2 - Fort Cox Scrub, 1937 Morgen	▨
Woodland Type 3 - Nqhumeya Scrub, 5298 Morgen	▨
Woodland Type 4 - Zanyokwe Bush, 4015 Morgen	▨
Woodland Type 5 - Dry Forest, 3920 Morgen	▨
Unmapped, 725 Morgen	
Woodland Type 6 - Moist Forest, 5017 Morgen	▨
Woodland Type 7 - Macchia, 7711 Morgen	▨
Exotic Trees, 777 Morgen	▨
Vlei Vegetation, 120 Morgen	▨
Helichrysum argyrophyllum, 1950 Morgen	▨
Grassland (including cultivated ground) - Sweetveld near woodland types 1 to 4, sourveld elsewhere, 31931 Morgen	☐
Meteorological Stations	■
Transects	
Approximate Boundary of Keiskammahoek District	— — —

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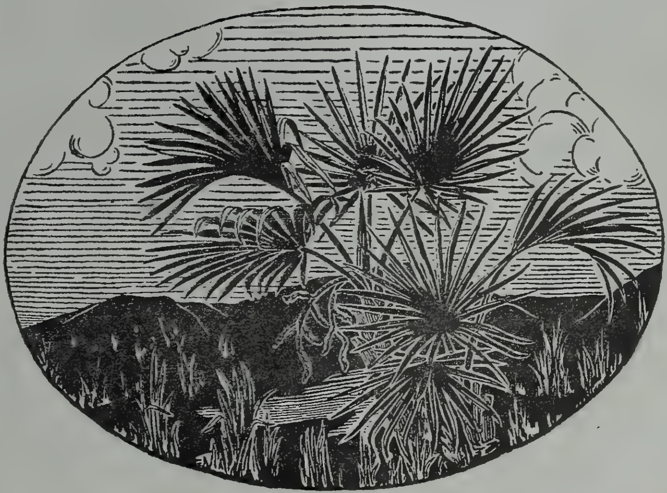

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DEPARTMENT OF AGRICULTURE

DIVISION OF BOTANY

BOTANICAL SURVEY MEMOIR No. 28

VELD TYPES OF SOUTH AFRICA

(With 5 small vegetation maps and accompanying Veld Type Map)

By

J. P. H. ACOCKS, M.Sc.

BOTANICAL SURVEY OFFICER, DIVISION OF BOTANY

THE GOVERNMENT PRINTER, PRETORIA, 1953

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FOREWORD.

The " Veld Types of South Africa " by John P. H. Acocks has been eagerly awaited by workers in many fields of study. It is now nearly 20 years since Dr. I. B. Pole Evans prepared his coloured vegetation map of the Union for Botanical Survey Memoir No. 15. Since then a great deal has been added to our knowledge of the distribution and classification of our flora. Road communications have vastly improved which has made it possible for Mr. Acocks to cover the large area of the Union very thoroughly. However, he has not yet been able to survey all the different veld types in equal detail and is continuing with his programme.

From his student days Mr. Acocks has been an ardent plant geographer. In 1935 he joined the Department of Agriculture as an ecologist, and in the course of his studies has travelled and collected extensively over most parts of the Union. As a plant collector he is a second E. E. Galpin. He has amassed a vast amount of data, of which the present work is a mere summary. It is, nevertheless, in sufficient detail to meet the main requirements of anyone interested in the composition and distribution of veld types in the Union, be he farmer, agriculturist or professor of botany. It will be especially valuable to officers of the Department of Agriculture in their aim to correlate farming practice with vegetation cover. Mr. Acocks endorses the grave warning so often heard in these times that unless the Department does succeed in this vital matter of soil and veld conservation the country faces ruin by the general advance of desert conditions.

It has been mentioned that the present account is a summary of what has been recorded so far. Owing to the many urgent needs which the vegetation map will meet it was decided to proceed with its publication with as little delay as possible. Thus any shortcomings due to unequal treatment and curtailment of text must not be attributed to the author.

The original of the large coloured Veld Type map was prepared by Mr. Acocks—himself an artist—but this does not lessen our gratitude to the Department of Trigonometrical Survey and to the Government Printer for the excellence of the reproduction. It is both an accurate guide and a work of art.

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and

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of South Africa.

Pretoria,
27th June, 1952.

CHAPTER I.

INTRODUCTION.

Earlier vegetation maps of the Union, those of Pole Evans (1935), Adamson (1938) and Pentz (1947), are on the broadest lines, recognizing only 19, 14 and 21 vegetation types respectively. In 1945 the present survey was initiated and, for general utility, it was decided to draw the vegetation boundaries on the existing 1: 1,500,000 Postal Communications Map. It has to be admitted that the basic map contains certain inaccuracies, particularly as regards the positions of country post offices. Thus in using the Veld Type Map, this must be borne in mind in cases where a post office appears to be situated in the wrong veld type. The western half of the Union is mapped in less detail than the eastern half; so is the north-western Transvaal and Basutoland. The north-western Transvaal was mapped by Irvine (1941), accompanied in the later stages by the present writer, and Irvine's map has been taken over with minor modifications.

The collation of field-notes and other available information is not yet complete, nor has it been possible to study all the relevant literature. This account, therefore, is a preliminary description of the map, and is an outline of the botanical and related agro-ecological problems and theories which it is hoped to discuss in detail at a later date.

VARIABILITY OF VEGETATION.

Even though this new map recognizes 70 veld types, plus 75 variations, the fact remains that it, too, is on broad lines. Every farmer knows that variations in the veld, even over short distances, are legion. These small variation are of great importance in farm management and, in the course of time, should be mapped farm by farm. Every farmer who knows his job allows for them, but a large part of the erosion damage throughout the country is the result of not allowing for them. This subject will be elaborated below.

To give an idea of how great this variation in the veld may be, a section of a detailed map of a 700 morgen farm, namely, Towoomba Research Station near Warmbaths in the Transvaal, is included in this Memoir (Diagram 1). Besides natural variations resulting from variations in soil, some so subtle that a soil survey failed to reveal them, this map shows the variations that can result from varying grazing treatment. Not all the vegetation of the Union is as variable as this sample of Bushveld, yet even an apparently uniform veld type like Karoo shows the most surprising variation when one examines it closely. It should be remembered that sheep and cattle examine it more closely than anyone.

Vegetation changes according to the way it is treated. This is the essential fact that must be grasped if one is to understand the vegetation of a recently settled country like South Africa. There is little or no vegetation in South Africa which is in its original condition, and this has not been made sufficiently clear in previous accounts of our vegetation. The scantiness of records of vegetation as it was when Europeans settled the country, makes it difficult to define the changes which have since occurred, enormous though some of them undoubtedly are. Fortunately, the changes are not yet complete. Notes made by the writer 14 years ago in the Kimberley area show that Karoo has in the interval largely replaced the grassveld constituent of the Thornveld; and the Karoo has nearly overrun the Dry *Cymbopogon–Themeda* Veld in the southern Free State and north-eastern Cape.

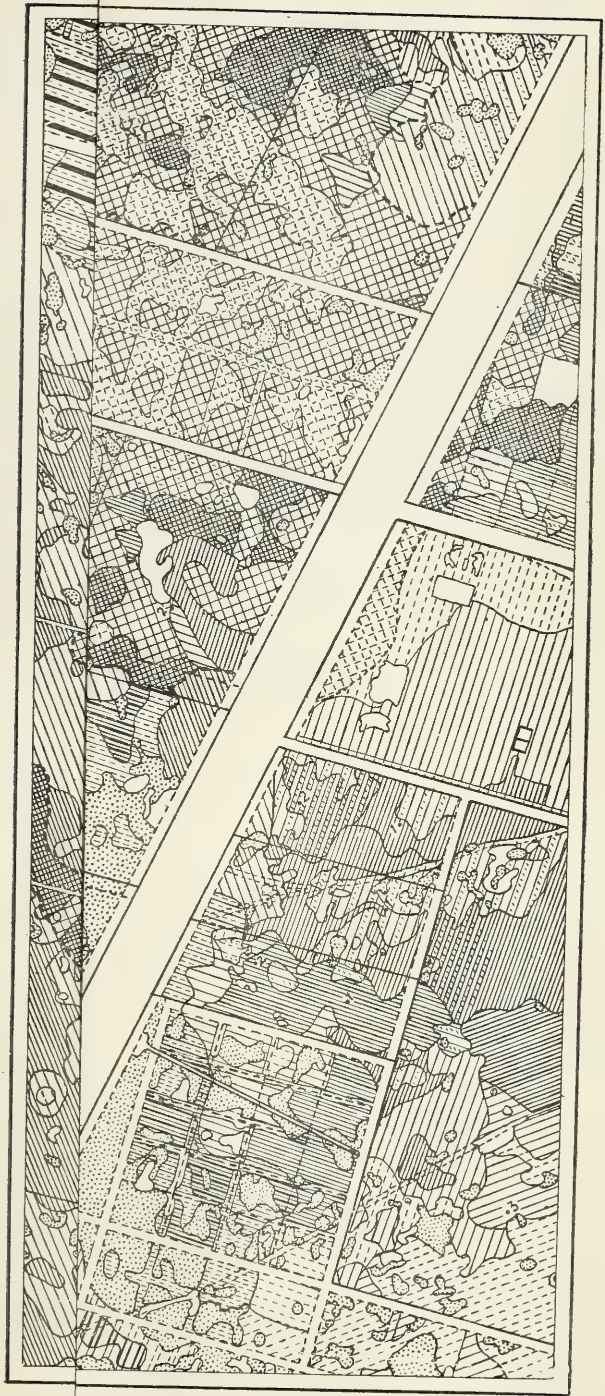
DEFINITION OF THE TERM VELD TYPE.

Before going further, the term " Veld Type ", as used in this memoir, must be defined. Vegetation is made up of individual plants, few or many, according to the habitat, belonging usually to a number of different species; they live together, competing with each other and perhaps assisting each other, so that a balance is maintained at a level of development determined by the locality or environment. From a consideration both of botanical composition and of practical utilization, one arrives at the concept of the Veld Type—*a unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities.* The environment includes many variable factors, such as grazing animals, birds and insects, light, heat and, most important of all, water. With variations in environment one gets variations in the vegetation and the problem is to group the infinite variations of the vegetation into manageable units, and to separate the natural variations from the man-made ones. Seeing that the vegetation of the Union is made up of 15,000 to 16,000 species of flowering plants, the possibilities of variation are endless. But all the species do not occur all over the country; in fact, not a single one does, and the great majority are scarce and localized, and for practical purposes one has to deal with about 2,000 more or less important species. Some of them are widely distributed over a number of obviously different vegetation types, while others are strictly confined to one type of vegetation. It is possible to select relatively few species which will serve as indicators of different kinds of vegetation and of changes in vegetation, whatever the unit decided on.

Such a concept of Veld Type as adopted can allow quite a wide botanical variation, e.g. in the case of the Mixed Bushveld or the Arid Karoo; but the Veld Type being a vegetation unit, this variation is limited to variation in the relative importance of members of a group of species occurring all through its area. When the species change, a new Veld Type must be established. Thus the Arid Lowveld–Bushveld, although it is Mixed Bushveld, has been separated from the Mixed Bushveld of the north-western Transvaal because its species composition differs.

ORIGINS OF VELD TYPES AND THEIR INTER-RELATIONSHIPS.

An interesting aspect of the mapping of the veld types is the disentangling of their origins and inter-relationships; firstly, because vegetation is always trying to migrate into *drier* habitats by virtue of the process of Succession, so that any movement (such as we find in South Africa) of a vegetation type into a *wetter* habitat is of particular interest and importance; and secondly, because in South Africa we have two entirely distinct floras, viz. the Southern Fynbos (or Sclerophyll) and forest of the winter rainfall area, and the tropical forest, savannah and grassveld of the summer rainfall area. Although entirely different in nature and origin, they are to-day almost inextricably mixed, and have co-operated to produce that quite distinct vegetation type, the Karoo, with all its variations. It is clear enough that the tropical vegetation has in the past migrated southwards and westwards along the wetter eastern side of the country and to some extent into the drier western parts; it is equally clear that to-day the Fynbos and Karoo are moving eastwards and northwards at a phenomenal speed into the territory of the tropical vegetation, and that the advancing Karoo is leaving behind it a desert " vacuum ".



Warmbaths, Transvaal.

Both these kinds of vegetation are considered to be very old, and to have been well established long before the grasses were evolved. Grasses are so indispensable to-day in covering and holding the soil, that it is difficult to understand the continuance, in a mountainous condition, of an old land surface without them. In the Fynbos, however, we have a vegetation-type which is capable of covering the soil fairly adequately without the help of grasses, which the tropical vegetation cannot do in areas unsuitable for the development of closed scrub or forest. It is reasonable to suppose, therefore, that, in the days before there were grasses (and quite apart from possible climatic differences), some form of Fynbos had a much wider distribution in areas which are to-day Tropical Grassveld and Savannah; and that it was pushed back by the sward-forming tropical grasses, when they appeared, into its strongholds in the winter-rainfall areas, and areas on mountain ranges and along coastlines where winter moisture is available and conditions are less suited to the tropical grasses. The picture is obscured by the surging backwards and forwards of vegetation types in response to less ancient changes of climate which we know to have more than once occurred. The relicts of Fynbos in tropical vegetation, therefore, may have more than one origin, though the presence of *Erica* in Europe and of *Podocarpus* and *Protea* in Central Africa is likely to be an indicator of the ancient distribution of Fynbos. It must here be pointed out that these climatic changes probably occurred over periods of tens of thousands, or hundreds of thousands of years, and not over periods of a century or less, like the change in vegetation we are witnessing to-day. Further, although there is some evidence (Brooks, 1926) that there are also minor fluctuations of climate with a periodicity of about 200 years, these cannot be invoked to explain the changes that are going on to-day, because these changes are too great to be reversible in the space of 100 years without leaving far more relicts than actually exist.

The origin of the Karoo flora is of particular interest. Bews (1925) supposed it to be derived from the Bushveld via the Fish River Scrub. That seems likely enough for the Great Karoo and Little Karoo, where most of the large shrubs are actual Bushveld species and many of the succulents are either Bushveld species or closely related, but not all the Karoo flora can be so derived. The succulent habit is not peculiar to any one vegetation type, but is rather a reaction to habitat, in particular to a permanent scarcity of moisture. Succulents are represented in all the veld types of South Africa. Those of the Karoo, therefore, can be derived from both the southern and the tropical floras. An interesting point is that our solitary representative of the Cactaceae (*Rhipsalis*) is a forest species. The other important constituent of the Karoo, the non-succulent shrublet or Karoo-bush, has become relatively scarce in much of the Little Karoo and Great Karoo, but is still dominant in the Upper Karoo and the False Karoo types; the origin of this plant-form is not to be sought in the tropical flora, where it scarcely occurs, but in the Fynbos. Common genera in the Karoo like *Chrysocoma*, *Hermannia*, *Euryops*, *Pteronia*, *Eriocephalus*, *Selago*, *Walafrida* and *Lightfootia* are all well represented in the Fynbos; *Pentzia* and *Phymaspermum*, too, in some forms of Fynbos; and there is a very good transition from Fynbos and Arid Fynbos through Mountain Rhenosterveld and the Western Mountain Karoo to the ordinary short kind of Karoo, both in species-composition and growth-form. There is no such transition from Karoo to the arid types of Bushveld, the Karoo simply petering out in this direction. This is well seen in the southern part of South West Africa, where, on the other hand, the contribution of Acanthaceae, Euphorbiaceae and Amarantaceae to the Karoo flora by the tropical flora is clearly seen, as is the contribution of shrubs and trees to the north-western forms of Karroid Broken Veld. To-day there appears to be a transition to the Bushveld in the south-east, because the Karoo has invaded the Noorsveld and Fish River Scrub, with *Pentzia incana* playing an important part; but there are indications that, in the natural state of affairs, there would be a grass savannah and bush clump veld separating the Noorsveld, etc., from the Karoo. In this event the undergrowth in the Noorsveld would have been grasses of tropical origin, e.g. *Themeda, Setaria, Panicum, Eragrostis, Enneapogon* and *Aristida*, all of which are still to be found in protected places, and they form a dense grassveld, dotted with small trees and a few large Karoo bushes, in protected parts of the surrounding Karroid Broken Veld.

It would seem, therefore, that the Karoo has a strong Fynbos affinity, especially the Upper Karoo and the Western Mountain Karoo; and that when Man disturbs the tropical grassveld and scrub, and induces a Karoo invasion, it is these Fynbos-derived elements of the Karoo which play the leading part. That is to say, the changes in vegetation which are occurring to-day are an artificial reversal of the evolutionary replacement of the southern scrub vegetation by a sward of grass of tropical origin. That is in broad terms, of course; there are minor changes too, the most important of which is the replacement of Tropical Grassveld by Bushveld via Thornveld, with the Karoo ever moving forward. The view is taken that the Ecology of South Africa is something dynamic.

MIGRATION ROUTES.

A study of all available information on plant distribution, taken in conjunction with the topography and rainfall distribution of Southern Africa, will show the main plant migration routes to be:

A.—From the North.

(1) Along the East Coast, i.e. on the seaward side of the Drakensberg and other mountains southwards. In the drier parts northwards and southwards the mountains themselves become important for more mesophytic species. (Examples of this type of migration are: *Scutia myrtina, Eulalia villosa* and *Ptaeroxylon obliquum.*)

(2) The tops of the Drakensberg and other mountains and the Highveld; cold, rather flat country. (E.g. *Myrsine africana, Setaria flabellata, Euphorbia clavarioides and E. pulvinata.*)

(3) The hot, but fairly wet, river valleys down the East Coast and inland, e.g. Tugela, Umzimvubu, Bashee, Kei, Keiskama, Great Fish, Sundays, Gamtoos and Gouritz valleys down the east coast; Limpopo, Harts, Lower Vaal and Orange valleys inland. (E.g. *Panicum maximum* and *Gymnosporia buxifolia.*)

(4) The Kalahari; flat, hot, semi-arid to arid sandy country. (E.g. *Acacia giraffae, Lepturella capensis* and *Anthephora pubescens.*)

(5) South West Africa; hot, rocky, partly mountainous country, ranging from semi-arid in the north to very arid in the south. (E.g. *Aloe dichotoma, Parkinsonia africana* and *Phaeoptilum spinosum.*)

(6) The West Coast, inhospitable desert. (E.g. *Cladoraphis spinosa* and *Zygophyllum morgsana.*)

(7) North-east Cape and southern Free State: mountainous and fairly wet country at a moderate elevation, linking the east coast route with the Inland Valley route. (E.g. *Aloe ferox*, *Olea africana* and *Rhynchelytrum repens*.)

B.—From the South.

(8) Along the south coastal mountain ranges and thence along the Drakensberg; wet country. (E.g. *Danthonia stricta*, *Passerina* spp. and *Erica caffra*.)

(9) Along the west coastal mountain ranges; wet in the south, dry in the north. (E.g. *Montinia caryophyllacea*, *Lobostemon argenteus* and *Diosma eckloniana*.)

(10) Along the south and east coasts. (E.g. *Danthonia curva*, *Passerina rigida* and *Agathosma* spp.)

(11) Along the mountain ranges of the Karoo region and thence along the Drakensberg. (E.g. *Danthonia disticha* and *Passerina montana*.)

It is clear that sea coasts, continuous mountain ranges and broken country (whether it consist of mountains rising out of a plain, or of deep valleys sunk into a plain), form particularly favourable migration routes for a wide variety of plants. The sea coasts are under the moderating influence of the sea and are more or less frost-free in our latitudes, even though they may be arid; the mountains usually receive a better rainfall than the plains, while the valleys, although tending to be drier, are usually warmer than either the plains or the mountains. The mountains and valleys provide a wide variety of climatic conditions: warm, dry northern and western aspects; cool damp southern and eastern aspects: frost-free areas resulting from peculiarities of air drainage; areas sheltered from the severity of winds; areas on the summits with a cold, severe climate or, on the other hand, benefiting by receiving winter-moisture, in the form of snow, during the dry season of the surrounding country; and so forth. They provide protection against widespread fires and are less accessible to grazing animals, in parts even inaccessible. Further, during major climatic fluctuations, these routes remain open far longer than does flat country, which provides no harbours of refuge for the many plants that have little power of adapting themselves to changing conditions. They have been used in the past, and they are being used again to-day, notably by the southern flora in its advance and the tropical flora in its retreat. Along the south coast, the Fynbos is using both the mountains and the plains, where conditions are not fully favourable to the tropical flora, for its advance; in the inland parts, on the Upper Plateau, Fynbos (in the form of *Elytropappus–Chrysocoma–Euryops–Danthonia* Veld) is similarly ousting the tropical flora from the mountain tops; but, on the other hand, the tropical grassveld is holding on to the slopes and rocky hills, especially on southern aspects, very successfully against the Karoo, even though it has been driven back hundreds of miles in the plains by the Karoo. In the Eastern Cape, in the dry parts, the Karroid (or Succulent) Bushveld holds on to the hills, but gives way to the Karoo on the plains, e.g. in the Great Fish valley; while in the wetter parts the tropical grassveld of the plains is unable to resist either the spread of the more arid tropical type, thornveld, or the spread of the Karoo, e.g. in the upper Swart Kei basin or in the Bedford and Somerset East Divisions. It is on the plains of the Eastern Cape, Orange

Free State, Griqualand West and the Western Transvaal that the most startling vegetation changes are to be expected in the near future, as the tropical grassveld retreats before a double invasion by thorn and Karoo.

As regards migrations in the past, the biggest that there is evidence for are (1) an ancient migration of the southern flora northwards to Abyssinia and even Europe and to Angola, and (2) that of the tropical flora southwards, which has continued until now. Relicts of the southern flora crop up all along the mountains on the eastern side of Africa and in Angola; and, within the Union, all over the country between the mountains and the east coast and as far inland as the Waterberg and Magaliesberg; they have not yet been found on the Langeberg in Hay and Kuruman divisions, but the vegetation of the top of this range is so much like Fynbos in form that the writer is confident that relicts will be found there. This range has certainly enabled some of the tropical grasses and trees to penetrate far into otherwise unsuitable country. The wide dispersal of *Aster muricatus* and of certain *Euryops* spp. *Delosperma* spp., *Stapelia* spp. and bulbous plants, suggests a former wider spread of the Karoo or some form of arid Fynbos; which links up with the present distribution of such species as *Portulacaria afra*, suggesting that these migrated down the east coast at a time when conditions were a good deal drier than they are now. On the other hand, the distribution of such species as *Nymania capensis* suggests that their migration from the north-west occurred at a time when conditions were warmer, if not wetter. The same applies to such species as *Azima tetracantha* which had to cross the Karoo plateau to reach the Kaap Plateau, but does not survive there to-day; or to *Rauvolfia caffra*, which occurs in sheltered kloofs on the northern side of the Magaliesberg and has no possible migration route from the coast under present conditions.

For as long as the ocean currents, winds and mountains have been as they are to-day, the general pattern of the climate will have been the same; this means that the east side of the country will have been a favourable migration route and the west side an unfavourable migration route, for the same length of time. Thus, although elements of the southern flora (*Protea*, *Stoebe*, *Philippia*, *Lightfootia*, *Thamnosma*) succeeded in reaching Angola, of the tropical flora only specialized desert plants (*Tamarix*, *Bauhinia*, *Adenium*, *Rhigozum*, *Commiphora*) have reached the Union by this route; and although many of the tropical species which have penetrated far to the south and west along the east coast route (including *Azima*, mentioned above) also occur in Angola, there is no sign that they ever migrated down the west coast or through the Kalahari. Exceptions are very few; *Sarcostemma viminale* appears to be one. Nor is there any sign that the Karoo ever reached Angola, or that it originated there or in that direction. These considerations might be taken to indicate, also, that the southern flora is older than the tropical flora, that at the time of this wider distribution of the southern flora, the Karoo had not been evolved; and that since that time there has been no conspicuously wet period, though there may have been exceptionally dry periods.

The vegetation we know to-day is primarily the resultant of all these migrations during millions of years, secondarily the resultant of the activities of the Bantu and European during the last three hundred years, and, in particular, the last one hundred years.

CHAPTER II.

INSTABILITY OF VEGETATION.

It must be realized that much of the erosion damage in the country is the result of not allowing for the small variations in the veld in grazing management. These small variations are mainly caused by soil differences: e.g. an accumulation of silty soil in a depression, however small, or along a valley, will have a somewhat different vegetation from the surrounding veld, usually more palatable and tending to remain green longer, because it gets more water; or the richer soil in the shade of a group of trees will have a softer, sweeter vegetation; or the heavier soil around an antheap will carry a more palatable vegetation than the open veld. The consequence is that grazing animals, particularly sheep, tend to concentrate in such areas, causing undue grazing pressure, denuding the soil and making conditions suitable for a concentration of water through increasing run-off. This may be termed " zonal selective grazing ". It is particularly noticeable in mixed veld, e.g. the Mixed Bushveld of Warmbaths or the Dry *Cymbopogon—Themeda* veld of the Orange Free State.

The same phenomenon, in an aggravated form, has resulted from the old practice of driving livestock long distances to water and kraaling them for the night. When natural surface waters (rivers and springs) were the only sources of drinking water and carnivores were a menace to stock, there was no help for this practice. The result was a denuded zone along rivers and around springs, especially in the more arid parts of the country where the vegetation has little resistance to over-grazing and trampling and recovers slowly. In these parts it is still often unnecessary to consult a map to find out if one is approaching a big river—a desert-like condition is a good indicator. Denuded veld is seen on town commonages, at some mission stations and around irrigation settlements; but on many farms the phenomenon is disappearing as a result of fencing, provision of water from boreholes in each camp and the elimination of the kraaling system. Selective grazing is actually the most urgent problem in grazing management, and although the Pasture Research Stations have devoted much attention to it, there seems to be little general realization of its importance. Its effects can often be well seen on European farms adjoining Native reserves when one camp of each area is given a season's rest, e.g. in the Victoria East division; here the rested camp on the farm will, with few exceptions, produce only a tall, open growth of *Sporobolus*, *Digitaria* and *Aristida* whereas the rested camp in the reserve will often produce a dense growth of *Themeda* and other climax species. This can be very surprising if one has not previously got down on one's hands and knees and examined the half-inch growth of grass in the reserve, to discover it to consist of all the climax species. In the former case, selective grazing has removed the climax species; in the latter case, heavy non-selective grazing has preserved them, at least in places where erosion has not removed them bodily along with the soil. This interesting observation can lead one directly to the most fundamental principle of grazing management, viz. that grazing should be heavy for limited periods and must not be continuous. It must be alternated with periods of resting. Close observation also leads one to the conclusion that many of the Native reserves, especially in the sourveld of the Transkei, are not in such an appalling state as they are popularly supposed to be, and that reclamation of the veld will be easy once rotational resting can be applied to it, providing soil erosion has not been excessive in the meantime.

The effect of selective grazing is evident throughout the country; and it is mainly responsible for the virtual disappearance of grass from the Karoo and the development of such useless veld types as the 'Ngongoni Veld. It must be emphasized that this survey has convinced the writer that there can have been no part of the Union of South Africa which did not originally have a cover either of forest and closed scrub-forest or scrub, or of perennial grass, even in the winter rainfall area and in regions receiving less than five inches of rain per annum. The accepted idea of Karoo as being bare soil dotted with Karoo bushes (or, as H. V. Morton puts it, of Karoo bushes each in its own little desert) and occasionally covered with annual grasses and succulents, is a completely false one. That condition of bareness is an artificial one, and even to-day, in spite of the largely soilless and apparently grassless condition of the Karoo, perennial grasses are surprisingly plentiful when one starts looking for them. Moreover, they are always eaten flat, even grasses which in existing grassveld are not regarded as palatable, so that one must conclude that the most palatable grazing plants in the Karoo are still grasses, and that the Karoo bushes are valuable mainly as reserves for winter and droughts when there is no green leaf left on the grass tufts. It must also be realized that the great bulk of the Karoo bushes are unpalatable and that the unpalatable ones are steadily on the increase, a further result, of course, of selective grazing. The parts from which the perennial grasses and the better Karoo bushes have practically disappeared are the parts which have come to be regarded as useful only for goats and karakul sheep.

In the United States of America it has been calculated that the original population of game, when the European arrived, was two and a half times as great as the present population of domestic livestock, both calculated in cattle units; and yet the vegetation was far better then than it is to-day. In this country we have no numerical records of the game population, but, from general accounts, it was enormous; why then, when wild animals are replaced by domestic animals, does the veld deteriorate? A few reasons have been suggested. Firstly, there were a large number of different species of wild animals, and presumably they did not all have the same grazing habits and preferences. Secondly, the wild animals, with some exceptions, were dependent on natural surface waters; when these dried up, they had to move elsewhere or die, so that the veld was not grazed over and over again in search of the last overlooked stubble, and any rains which were too small to replenish surface waters were nevertheless available to the veld. The veld did get a chance to rest and grow. Thirdly, the wild animals were free to roam and they had a habit of congregating in large herds and "trekking", so that the veld was grazed heavily but intermittently, and not continuously. The old herding and kraaling system had one advantage, for at least some parts of the farm had a chance to rest, which is rarely so to-day.

What are the consequences of continuous, selective grazing? Firstly, change in the species composition of the veld, good grazing species becoming eaten out and replaced by less useful species in the wetter parts, but possibly not replaced at all in the drier parts, so that soil becomes exposed. Even in the wetter parts, the cover of the soil is reduced. That leads to the second effect, increased loss of water by run-off and sheet-erosion while wind-erosion may occur too. This reduces the depth and quality of the soil and makes the recovery of the vegetation, even if it is given a rest, slow and difficult. The shallower the soil in the first place, the bigger this effect. Thirdly, due to increased run-off, rivers are called upon to carry more water after rains. The first effect of this is to silt the rivers up, filling pools, smothering the vlei vegetation; the next effect is that their channels become scoured out and deepened, so that water draining into them falls over a bank, and dongas start eating back.

CHAPTER III.

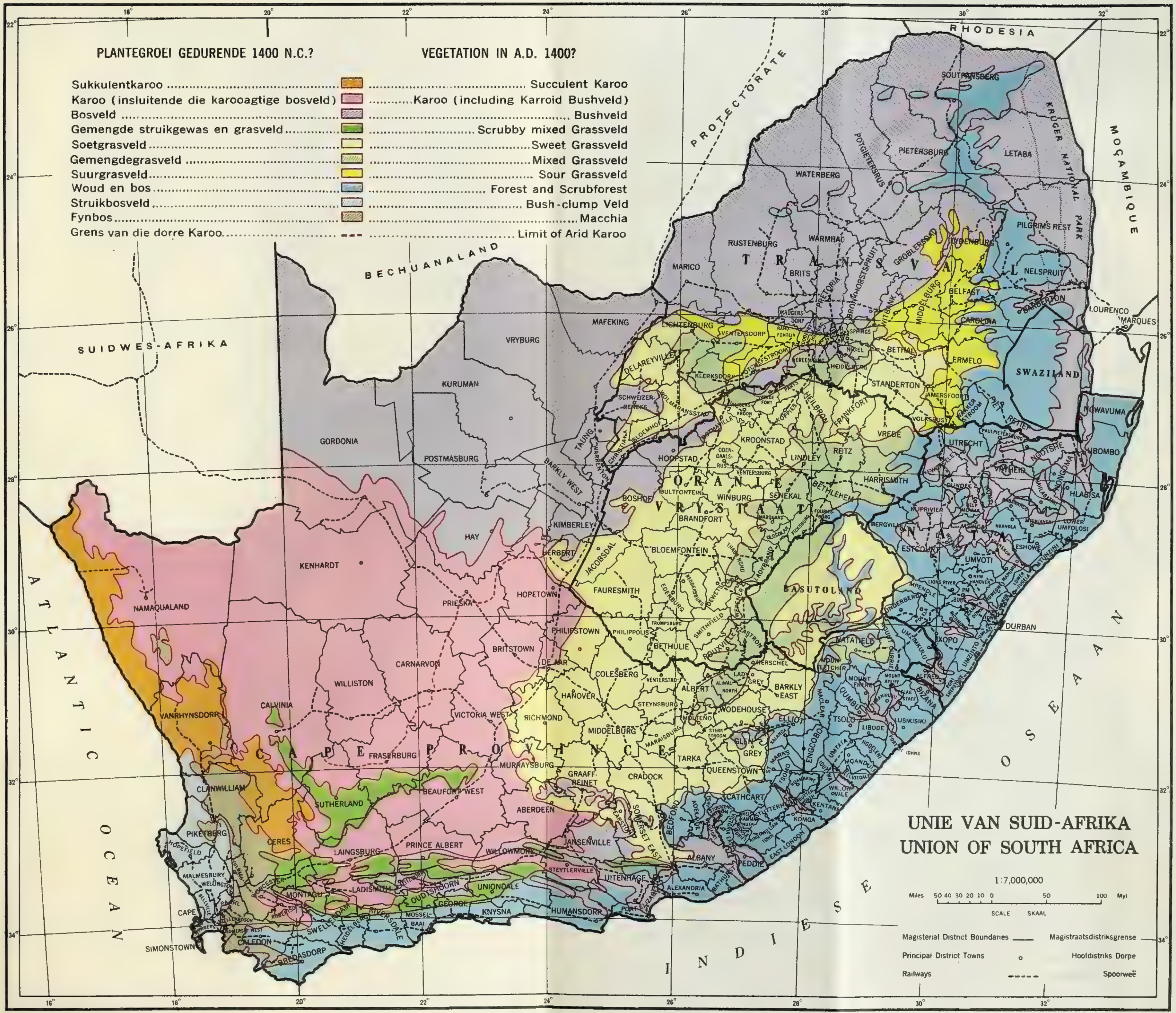
RECENT AND FUTURE CHANGES IN VEGETATION.

A DISCUSSION OF MAPS 1–5.

Maps 1–5 are intended to show, in simple form, what the vegetation was (1), is (2) and (5), is likely to become (3), and could become if it were reclaimed (4).

Map 1.—In drawing Map 1, there is no direct historical evidence to go on, i.e. evidence in the form of vegetation maps or botanical analyses of definite samples of veld that could be revisited and re-analysed today. What little evidence we have is indirect, e.g. the naming of Vasco da Gama of the East Coast as the Land of Fire, in reference to the multitude of veld fires he observed from the sea; van Riebeeck's export of veld-hay from the Tygerberg to the East Indies; the rather vague descriptions of veld given by early travellers (Burchell, Barrow, etc.); the description by Davis, quoted by J. C. Brown in his " Hydrology of South Africa ", of the start of the eastward movement of the Karoo; Moffatt's statements about the destruction of wild olives near Griquatown or of camelthorns in Bechuanaland; and the mere fact that it was possible to travel by ox wagon through the Great Karoo to Graaff-Reinet and Beaufort West, with sufficient certainty of finding both grazing and water for the oxen, to justify a feeling of surprise if one did not find them (Kokot, 1948). This indirect evidence gives valuable clues and starting points for study; but for the rest (apart from memories of the older farmers, with nothing written down at the time in support of them), one is dependent on a study of the veld itself as it is to-day. All of the changes shown on the map can still be seen going on, so that there is no doubt about their reality; all that remains is to decide where they started. Fortunately, relict patches of formerly existing vegetation types can usually be found in spots suitable for their preservation, e.g. well cared for farms; rocky hillsides; edges of cultivated fields; the railway enclosure; cemeteries; camps set aside for the preservation of small herds of buck; cow camps of town commonages, and even along the roadside in parts of the country where fencing was carried out a long time ago. Otherwise, one must search the invaded area for relicts of individual species, which should be typical of the displaced veld type and of veld types successionally higher, and not occurring in the natural habitat of the invading type at all; e.g. *Tetrachne dregei* and *Rhus erosa* in the case of the Upper False Karoo.

The hardest boundaries to fix are those in flat and relatively flat country, e.g. in the Orange Free State and upper Karoo; but even here it will eventually be found that natural features, however, vague, provide the probable boundaries, e.g. the original eastern boundaries of the Arid Karoo and Upper Central Karoo both consist of minor escarpments and chains of hills. After the latter boundary had been decided on, with many doubts, it received interesting confirmation when Schulze (1947) published his climate maps of South Africa. According to both Köppens and Thornthwaite's classifications, a definite change in climate, *from temperate to tropical*, coincides with the supposed original boundary between Karoo and tropical grassveld. What would otherwise have been a highly controversial boundary thus becomes relatively unassailable.



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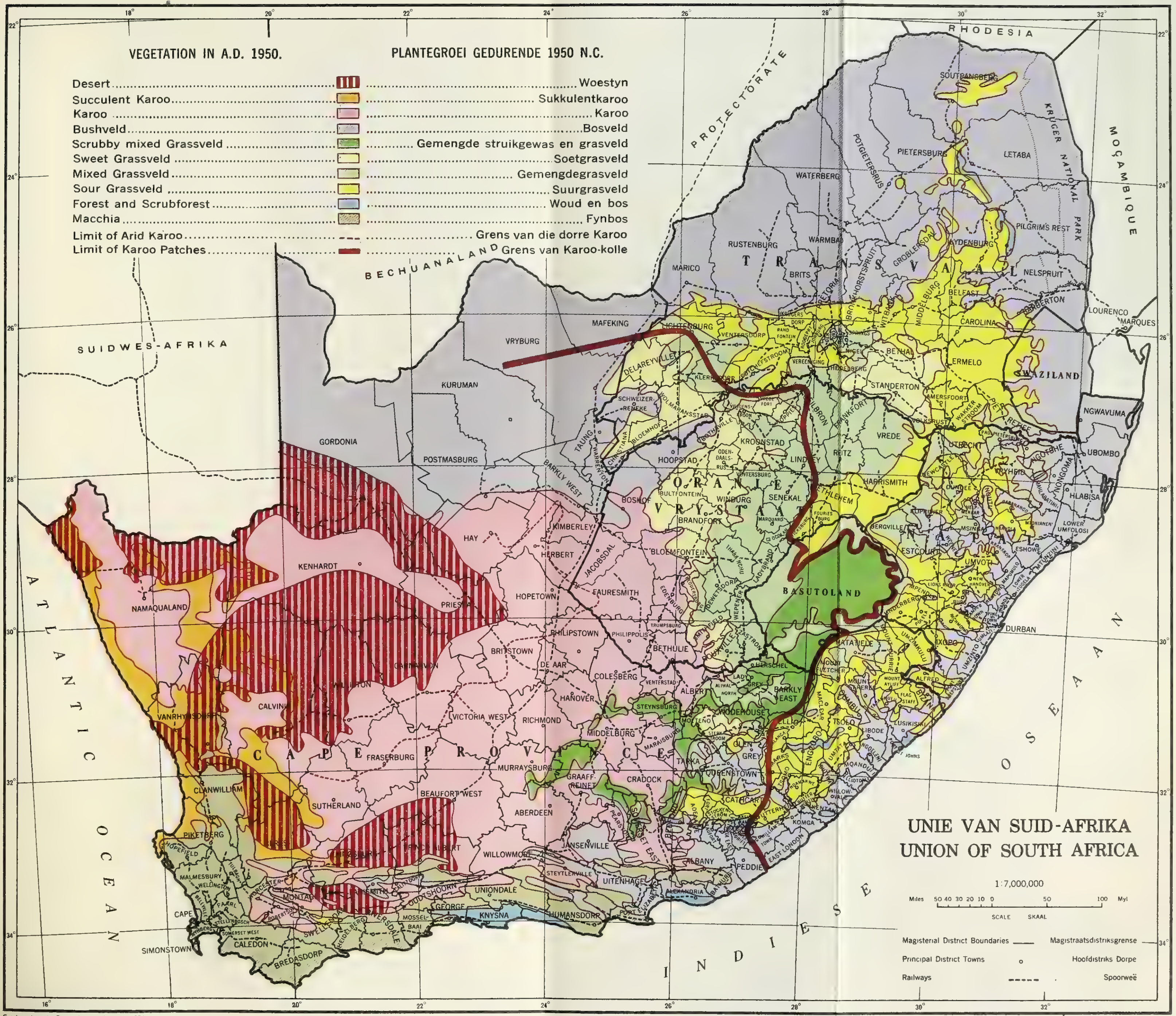

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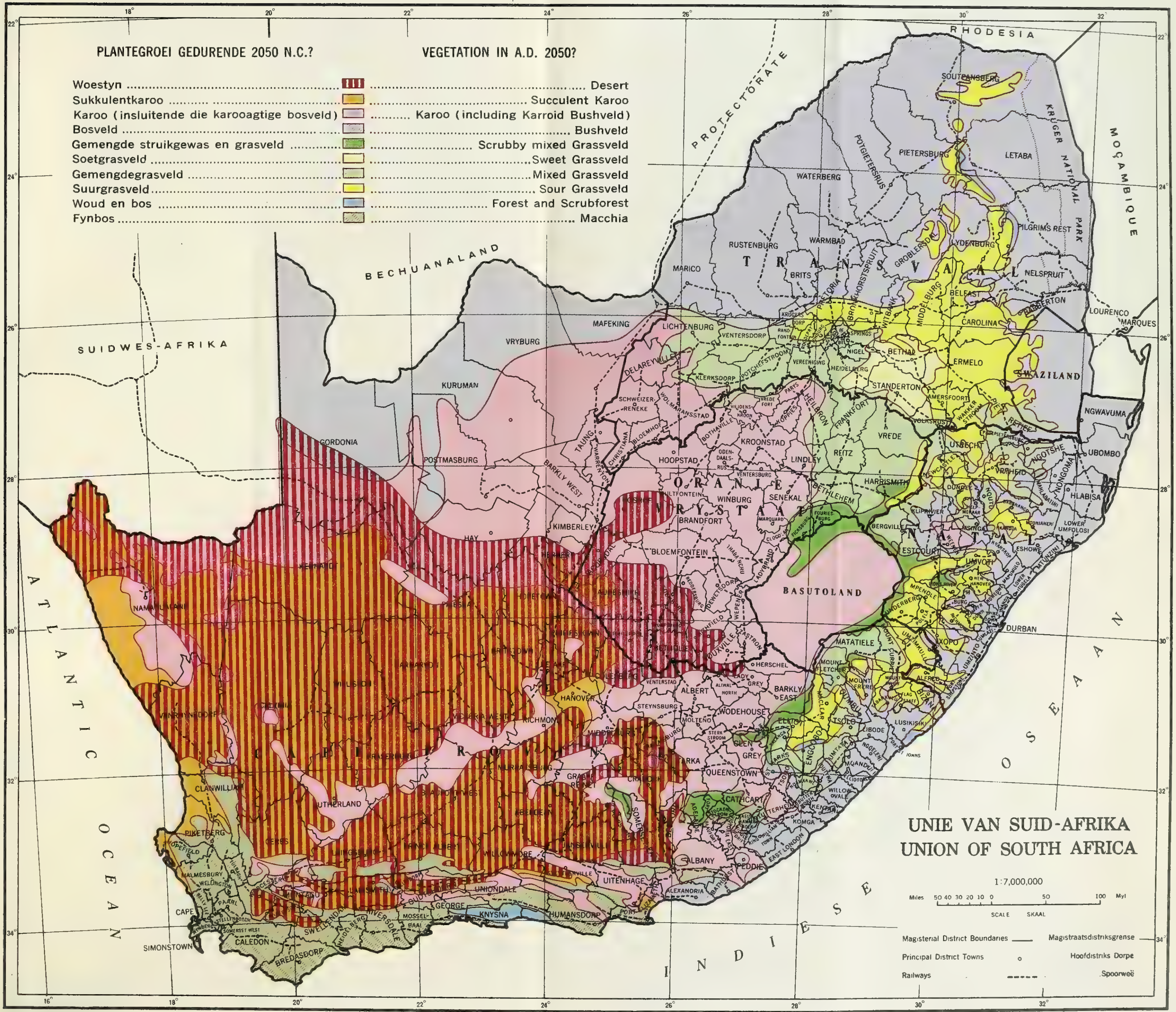

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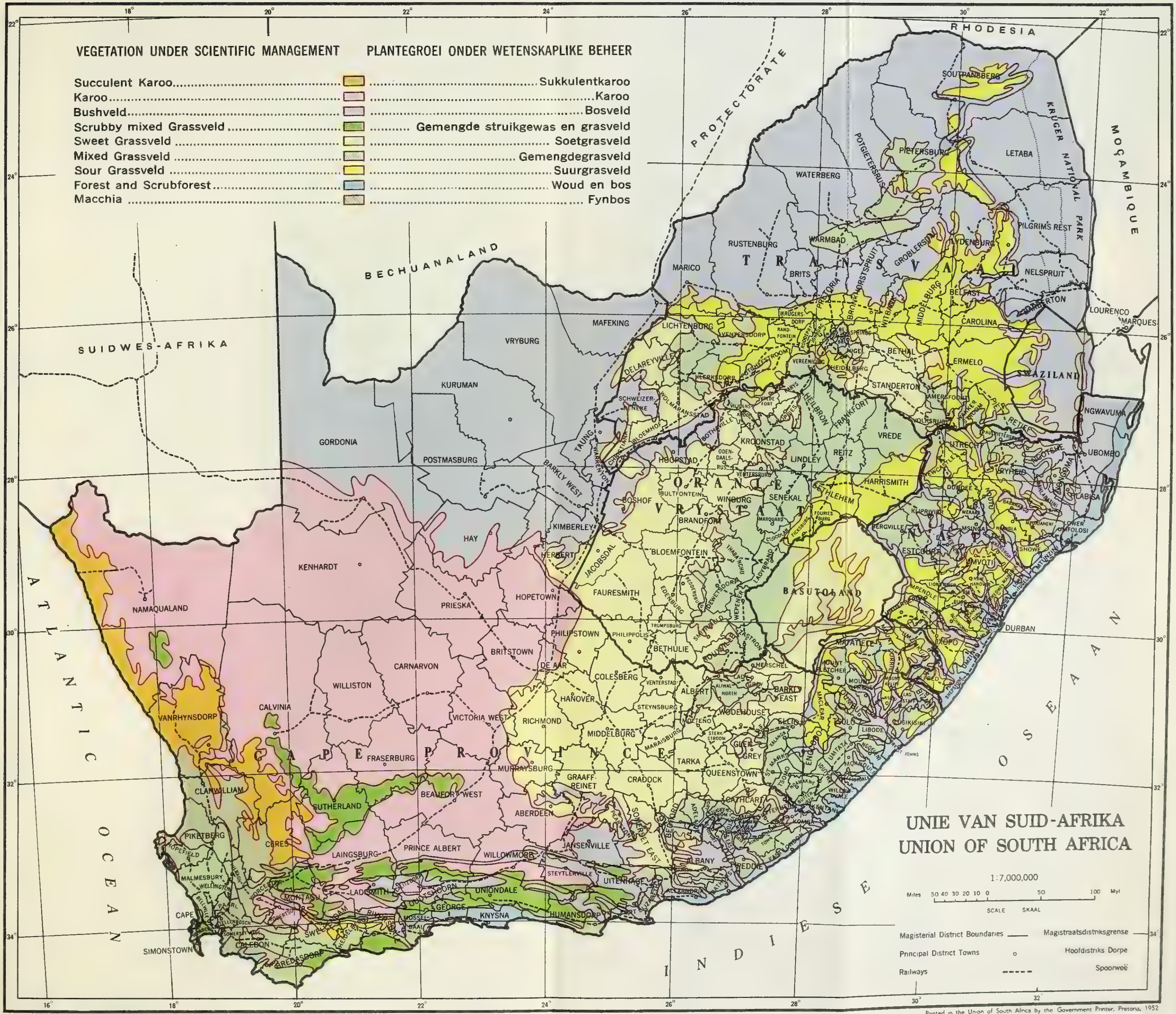

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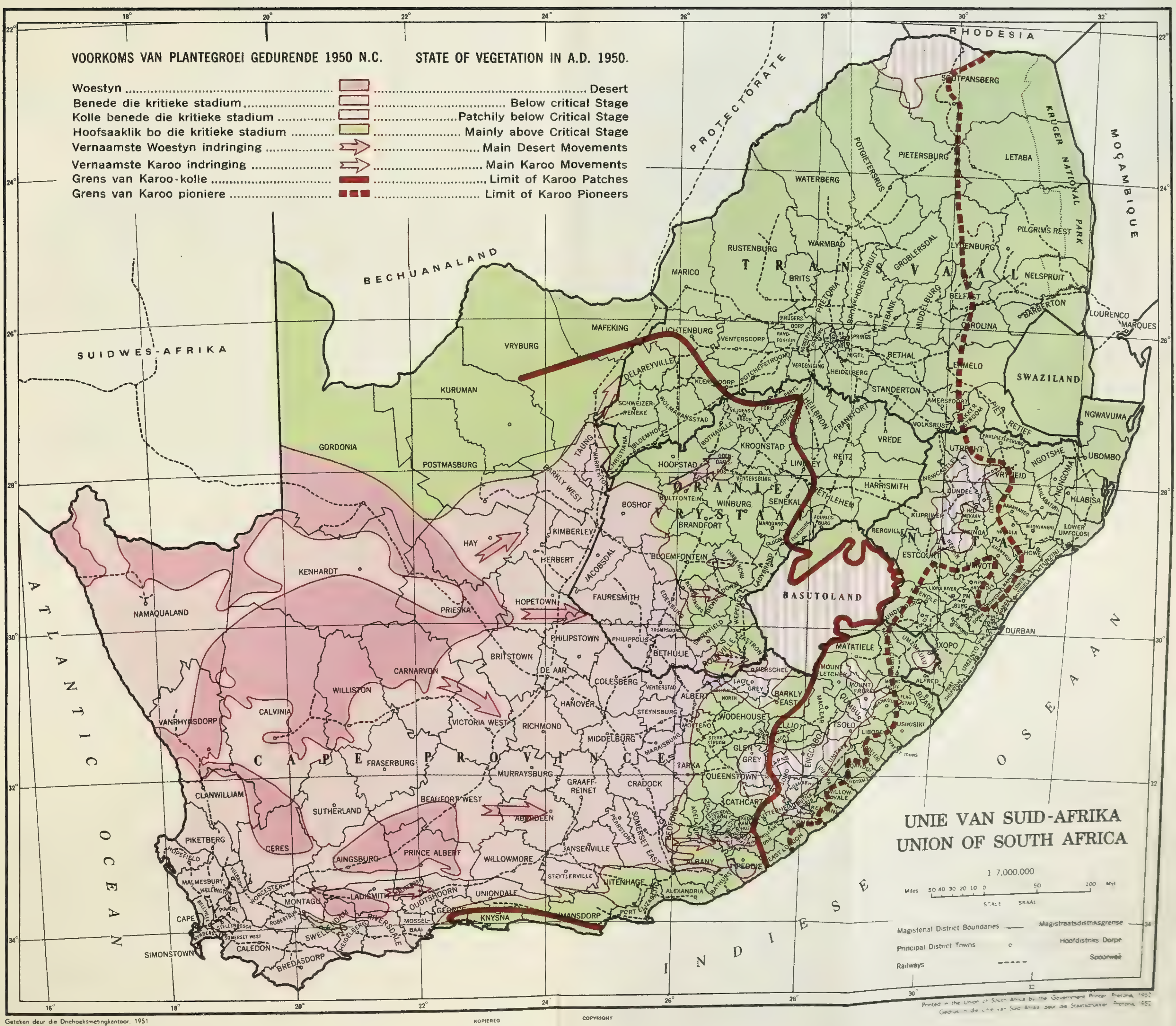

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Acocks Map No. 5

Map 2.—There is no difficulty about Map 2, because it is merely a simplified version of the veld type map, and in years to come it will be the basis for further comparisons.

Comparing Maps 1 and 2, we find the following changes suggested for the vegetation:—

(1) The forest and scrub-forest have largely disappeared. Scrub-forest was probably much more extensive than high forest, especially in the higher, more inland parts and on drier or waterlogged coastal plains. High forest would have been found in the shallower valleys, against escarpments and mountain sides which receive mist from the sea, and along the upper parts of the south-facing sides of the major river valleys, i.e. in the same situations where it persists to-day, but very much more extensive; shortening to scrub-forest on exposed ridges and flats in the colder and drier parts. It is probable that the upper parts of the north-facing sides of the deep valleys, as well as the upper middle parts of the valleys, where conditions are too cool for the bushveld of of the valley and yet too dry for the forest and scrub-forest, were open, grassy thornveld and bush-clump veld, characterized by *Acacia caffra* just as they are to-day.

Northwards into warmer country, the high forest would have been more extensive, covering the ridges too, as it still does sometimes, e.g. in Zululand and the Eastern Transvaal; but in these northern parts, with their very dry winter, high plains would still have had only scrub forest, owing to their frostiness. Regeneration of forest in a frosty area is extremely slow, because it can only proceed by outward growth of surviving patches of forest; in the presence of regular burning of the veld, this growth becomes still slower, because of the inflammability of the scrubby pioneer stages of the forest succession. This inflammability will also explain why relicts of scrub-forest are to-day rarer than relicts of high forest.

Along the south coast, with its well distributed rainfall, high forest was extensive in mountainous areas and it is here that the biggest areas of forest survive; but on the drier coastal plains, conditions were right only for scrub-forest, and, at the southern end of the west coastal plain, with its winter rainfall and hot, dry summers, there was probably only a bush-clump veld. These coastal plains have been so extensively cultivated that to-day there is very little of the natural vegetation remaining, most of this being Fynbos and Rhenosterveld, but there are traces of scrub-forest all through it, sometimes still so dense as to be quite impenetrable. Some of this scrub-forest on the west coastal plain is semi-succulent, and there probably was a transition, in the ploughed-up country south of the Piquetberg, from the coastal scrub-forest to the Namaqualand Broken Veld.

North-eastwards, the forest has been replaced by sour grassveld at higher altitudes, by thornveld and bushveld at lower altitudes, and by a certain amount of mixed grassveld at intermediate altitudes. Numerous patches of forest survive throughout; only a few of the bigger patches are shown in Map 2.

(2) Most of the bushveld and thornveld have persisted; but in northern parts, at higher altitudes, marginal bushveld has tended to be converted into grassveld, largely as a result of excessive burning. In recent years, burning has become less popular and the bushveld is tending to recover, e.g. on the Pietersburg Plateau. Southwards, thornveld has replaced a good deal of the forest and is actively

replacing the grassveld which resulted from the destruction of the more temperate forest and scrub-forest of the Eastern Cape, as well as much of the Dry *Cymbopogon–Themeda* veld, e.g. in the Queenstown area. The karroid bushveld (which should be rather called succulent bushveld) is shrinking in area, being replaced by Karoo and Karroid Broken Veld. In Griqualand West and the Eastern Cape, bushveld and thornveld are being invaded by Karoo; in the former case also by desert trees and shrubs, notably *Acacia detinens*, which tend to form thickets (as do such species as *Acacia gillettiae*, *A. tenuispina* and *Dichrostachys glomerata* in the Transvaal), and spoil the open, grassy nature of the veld, reducing its grazing value.

(3) The most striking, and alarming, change is the spread of Karoo at the expense of sweet grassveld. This spread of the Karoo eastwards has amounted to 150 miles in parts; it is still proceeding, as the red line indicating the limit of patches of Karoo shows, and the broken red line which indicates the limit of isolated individuals of the Karoo pioneers. These pioneers are well into the sourveld, and, in parts, have penetrated to the country east of the Drakensberg. The Upper Central Karoo, the Orange River Broken Veld, the Karroid Broken Veld and the Lower Central Karoo are all involved in this movement. There is also a northward movement, which has hitherto been much slower, but is showing signs of acceleration in recent years.

(4) Just as these wetter Karoo types are invading grassveld and bushveld, so too is the Arid Karoo invading the Upper Central Karoo, and the Succulent Karoo is invading the Arid Karoo and Western Mountain Karoo. The last movement is relatively small, so far, because the Succulent Karoo is rather a winter rainfall type and not so well adapted to the autumn rainfall areas which it is invading; in consequence it is a very poor, weedy type of Succulent Karoo which advances eastwards, scarcely to be distinguished from desert. There is another Succulent Karoo movement, rather more vigorous, from the Great Karoo, up the Great Fish River valley and into the False Karoo of the Middelburg and Hofmeyr areas, but not forming a definite succulent veld. There are no sharp boundaries to these internal Karoo changes, the Karoo tending to become a general mixture of all types, with the pioneers of the Succulent Karoo and Arid Karoo already penetrating almost as far as the False Karoo boundary in the east.

(5) Very extensive near deserts have developed in the west; rarely total desert in the sense that there is no vegetation at all, but near desert in the sense that soil erosion is universal and that there is no longer a permanent, unbroken vegetation cover, and only rarely a temporary cover. Only the bigger areas are shown in Map 2; smaller areas occur almost to the eastern boundary of the False Karoo.

(6) The Fynbos shows the biggest movement of all, having spread from the neighbourhood of Bredasdorp, Montagu and Touws River, to Grahamstown; it is now invading the Amatola Mountains. The vegetation of this area appears to have been a scrubby sort of mixed to sour grassveld wherever conditions were not suitable for forest or scrub-forest, and this grassveld would have replaced any forests that were destroyed. The fynbos species occurred all through, both as patches of Fynbos in rocky places, and in the subordinate position of forbs in the grassveld, just as they still do, e.g. at Swellendam. There is little doubt that grassveld first replaced the scrub-forest of the coastal

plains; indeed, small patches of *Themeda*—dominated mixed veld, as dense as any in the country, can still be found in the Coastal Rhenosterveld and Coastal Fynbos, nearly to the west coast. They occur in areas too wet or too stony ever to have been cultivated, i.e. the only areas that have not been cultivated. And even in the heart of the winter rainfall area, on relatively dry and warm aspects, resting of the Fynbos will produce a dense stand of *Hyparrhenia hirta* and *Themeda*, e.g. on the western slopes of Constantiaberg or in Tulbagh Kloof; while in the eastern part of the area, e.g. around Humansdorp, much of the vegetation is still grassveld, with Fynbos only in patches.

Such phenomena as the thickening up of *Athanasia acerosa* in parts of the mist-belt of Natal, of *Stoebe vulgaris* and *Helichrysum kraussii* around Johannesburg, and of *Cliffortia repens* and *Passerina filiformis* on the mountains near Vryheid, might reasonably be taken as a warning that this movement of the Fynbos has by no means reached its limit. Moreover, the Karoo which has invaded the inland parts of the scrubby mixed grassveld, the upper parts of the Karroid Danthonia Mountain veld and parts of the *Themeda–Festuca* Alpine veld, is that tall form of Karoo which may be claimed to be transitional to Fynbos, including species of *Elytropappus*, *Cliffortia*, *Passerina*, *Pentzia cooperi*, *Eumorphia*, sometimes even of *Philippia*, *Erica* and *Muraltia*, and so closely related to Fynbos that it is a debatable point whether it should not rather be counted as a Fynbos invasion.

(7) In various parts of the Union there are vague and insidious movements of *Acacia karroo*. It appears to be, by nature, a widely distributed species, perhaps having a successional position between the tropical forest and the bushveld, but growing also on river-banks in the Karoo, where there is an assured supply of underground water, even if the environment is otherwise inhospitable. It is now spreading eastward up the river valleys into higher altitudes in the Karoo and beyond into the grassveld. It appears to be at home on the low escarpment that runs through the Free State from the neighbourhood of Kopjes to Bloemfontein, and is thickening up and spreading there, e.g. between Bloemfontein and Brandfort; but odd specimens are also to be found in the heart of the Free State plains, while extensive thickets are developing in the grassveld of the Western Transvaal; these occurrences are usually associated with over-grazing and erosion and Karoo invasion, suggesting that even these parts are threatened by the development of Karroid Broken Veld. These movements are still too small to show on a small scale map.

There is also a westward movement of *Acacia karroo*, on a bigger scale, from the Valley Bushveld of the East Coast rivers into the grassveld of the Eastern Province and Transkei, and right into the surviving temperate forest of the mountains. This movement is not always preceded by over-grazing and soil erosion, and there are parallel invasions by this and other species (e.g., *Acacia arabica* v. *kraussiana*) into open savannah in the Transvaal and Natal; the reason is likely to be climatic deterioration. This westward movement of *Acacia karroo* in the Eastern Cape already overlaps the eastward movement of the Karoo, resulting in a form of Karroid Broken Veld (the *Acacia–Pentzia* Community of Adamson). Only the larger movements are indicated on the map, but minor movements are to be seen in the valley of nearly every east coast river, though in the Transkei they are limited by the scarcity of firewood.

(8) Besides spreading at the expense of the forest and the sour bushveld, sour grassveld has spread at the expense of the mixed grassveld, as a result of selective grazing.

(9) Similarly, mixed grassveld has spread at the expense of bushveld and sweet grassveld.

(10) There is little sign of movement of the Kalahari thornveld; indeed, it seems rather to be retreating, much of it having become thinned out almost to grassveld. This is not indicated on the maps.

These mappable changes are gross changes; in addition there are subtler changes within the veld types, in the relative abundance of the species composing them. This sort of change is difficult to assess and is done by a study of relicts; it is sometimes difficult to see that a change has occurred, e.g. in a forest the only indication may be the discovery of a fallen-in and overgrown saw-pit. These changes become most important when they lead to a breaking of the grass cover; Map 5 shows, on broad lines, where this has occurred and where, in consequence, general soil erosion is almost inevitable. Map 5 also shows where deteriotation has gone so far that near-deserts have developed; it should perhaps be pointed out that the survey of these areas was made during the recent severe drought, so that Map 5 may be a little pessimistic. On the other hand, it may be a true picture, because it was not obscured by temporary growth. In any case, these areas are not uniformly bad, because individual farmers have succeeded in keeping their veld in good condition, and some have even reclaimed it; such farms are conspicuous from afar on occasions when visibility is not limited by the dust of erosion.

Map 3.—Now, remembering what has been said about the position of Karoo and desert pioneers, of *Acacia karroo*, of desert outposts and of general deterioration in the vegetation and the climate, consider Map 3, which attempts to show what the state of the country is likely to be in another hundred years' time if nothing effective is done to halt the deterioration. It is considered that:—

(1) The present Karoo and False Karoo will largely have degenerated into near-desert False Succulent Karoo, except in some of the more mountainous areas and in areas of deep sand.

(2) The False Karoo will have spread approximately to the present limit of Karoo patches, and may have established itself in the Tugela valley.

(3) The succulent bushveld types will have been replaced by Karoo and Karroid Broken Veld, except in the valleys of the east coast belt.

(4) Sour grassveld will be retreating before the development of poor types of mixed grassveld.

(5) The scrubby mixed grassveld and its associated near-Fynbos scrub, will have moved eastwards and northwards to the Winterberg and Drakensberg and into Natal; it might well have become more extensive in those parts and northwards than shown.

(6) Sweet grassveld may succeed in holding on to the turf highveld, but will have disappeared elsewhere.

(7) Bushveld will have spread into more of the grassveld areas.

This map is an optimistic estimate of the changes that are likely to occur, being based on the following assumptions:—

(1) That the country east of the Drakensberg will suffer relatively little climatic disturbance.

(2) That the sandy lands of the Eastern Free State and Western Transvaal will not start blowing *en masse.* There is a good deal of superficial dust movement already, a fact which was impressed on the writer's mind during his first trip on this survey, when travelling over the mountains from Utrecht to Wakkerstroom in July, 1945. The view to the south was completely obscured by the dust coming over the Drakensberg from the west; this is, of course, of common occurrence, even as far south as Estcourt.

(3) That the Kalahari, at present a buffer between the northern parts of the Union and the growing deserts of South West Africa, will not be carelessly opened to grazing by provision of water, without very strict control of the grazing being maintained.

(4) That the Fynbos invasion will not go further than the Amatolas.

(5) That there will be neither a marked improvement in the climate, nor a marked deterioration, other than the minor sort of change already discussed.

If these assumptions, particularly No. 3, are not justified by events, far more serious changes may occur.

Map 4.—Turning from this ugly picture of what could be, consider Map 4, which is also a picture of what could be, but a pleasant picture. It represents the condition of the vegetation which, it is considered, consistent application of sound farming practice could have maintained; it is also the condition to which, so far as is now possible, the vegetation will have to be reclaimed before any sort of stability in South Africa's agriculture can be reached. It differs little from Map 1, except that it shows a far smaller area of forest and scrub-forest. Comparing Maps 1, 2 and 4, and remembering what has been said above, it will be seen that the objects of reclamation are considered to be as follows:—

(1) The near deserts in the west must be reclaimed, ecologically a relatively simple matter, because the powers of recovery of these arid veld types are amazing and they are less handicapped by climatic change than are the veld types further east.

(2) The False Succulent Karoo must be pushed back to where it belongs in the winter rainfall area.

(3) The False Karoo must be reclaimed to sweet grassveld. This is going to be the most difficult job of all, because soil erosion has made conditions unsuitable for the grassveld, and complete restoration may be found to be impossible.

(4) Mixed grassveld must be restored to the coastal plains of the South-west Cape, in place of Coastal Rhenosterveld and Coastal Fynbos. Improved methods of cultivation will demand this change, as well as a reduction of the area under cultivation. Where the grass is still present amongst the bushes, this will not be difficult, but where there is no grass, re-seeding and clearing of the bush will have to be resorted to.

(5) Scrubby mixed grassveld and mixed grassveld must be restored to the mountains of the Karoo and south coast belt, in place of Mountain Rhenosterveld, False Karoo and False Fynbos. Again, the amount of grass still present will decide whether this will be an easy

job or a difficult one. Tidmarsh's work in the Sneeuwberg shows that in the absence of grass it can be very difficult.

(6) A good deal of mixed grassveld must be reclaimed to sweet grassveld.

(7) A good deal of sourveld could, with advantage, be converted into mixed veld, particularly the Dohne Sourveld.

(8) The east coast thornveld should be converted into mixed grassveld and sour grassveld; and so should some of the more open Transvaal bushveld types. This means that only a few shade trees, patches of bush and all patches of forest should be kept, all scrubbiness being cleared away.

(9) Large areas of natural forest should be restored along the east coast and on mountains, especially the major escarpments. Smaller patches should be re-established on excessively steep places, at the heads of streams and along streams. The use of exotics wants more investigation; they appear to be extravagant with water, and although they may not transpire faster, the writer's observations suggest that they transpire longer, i.e. they may go on growing and transpiring long after the indigenous trees have become wilted and dormant.

(10) The karroid (or succulent) bushveld should be restored.

The essential feature of all this reclamation (except in the case of forests, of course) is the re-establishment of a cover of useful grasses. This applies to every corner of the country. In many cases weedy types of vegetation will have to be eliminated, sometimes before reclamation can start, sometimes during reclamation, but the rule must be established that *no clearing must be done unless it is known with certainty how to cover the soil with other vegetation at once, and until suitable steps have been taken to do this.* Otherwise erosion will result, as it has resulted from the destruction of prickly-pear; and the remedy may be worse than the complaint.

Map 5.—The widespread deterioration in all veld types over the last 500 years is indicated in the discussion of Map 2. The extent to which such damage can be repaired by relatively simple methods, such as resting and rotational grazing, depends on how far the deterioration has progressed. The breaking down of the plant cover inevitably leads to loss of soil and a consequent reduction in the effectiveness of the rainfall. Eventually a stage is reached when so much soil has been lost that even complete resting will not result in recovery of the vegetation cover within a reasonable period of time.

In the course of this deterioration in the vegetation, a stage is reached in which the vegetation, in particular the grass, is just able to protect the soil against erosion. This is the critical stage; any further deterioration is likely to result in general soil erosion.

CHAPTER IV.

DESCRIPTION OF THE VELD TYPES.

The description of the veld types which follows is to be regarded as a preliminary one. A great mass of data has been collected in the course of this survey and earlier. It has been partially sorted out, but requires further study; moreover, although some of the veld types could be described in great detail even at this stage, others cannot until additional data have been collected. The method that has been used more or less intensively for the past 15 years in collecting data for a description of the vegetation of the Union is as follows: a good sample of veld is chosen; one then writes down the names of all the species one finds (at the moment of finding them—this is important), walking around until one can find no more species. The distance one has to walk, and the time needed, varies with the veld type; thus a sample of Karoo flats or of the Free State plains can be taken adequately in 20 minutes, whereas a sample of a Karoo mountain may take three or four hours as a minimum. The longest list yet made included 302 species of the Scrub Bushveld of the Asbestos hills in a good season. The shortest list yet made included only five species, but this was of a sample of badly tramped-out Arid Karoo in Bushmanland during a drought. A Karoo mountain will yield 180–230 species, whereas the Karoo flats will not yield more more than 80, and some of the grassveld types not more than 40–50. The abundance of the species is then recorded by means of symbols according to the estimated spacing of the plants and, to allow for the patchiness of most veld, a variety of habitat symbols is also used, thus:

Abundance symbols:

vvab	1″ apart	12,960,000 per morgen	Extremely abundant.
vab	3″ apart	1,440,000 per morgen	Very abundant.
ab +	4½″ apart	640,000 per morgen	
ab	6″ apart	360,000 per morgen	Abundant.
ab —	9″ apart	160,000 per morgen	
c +	1′ apart	90,000 per morgen	
c	1¼′ apart	57,600 per morgen	Common.
c —	1⅔′ apart	32,400 per morgen	
f +	2′ apart	22,500 per morgen	
f	3′ apart	10,000 per morgen	Frequent.
f —	6′ apart	2,500 per morgen	
ff +	12′ apart	625 per morgen	
ff	15′ apart	400 per morgen	Fairly frequent.
ff —	20′ apart	225 per morgen	
o +	30′ apart	100 per morgen	
o	50′ apart	36 per morgen	Occasional.
o —	75′ apart	16 per morgen	
r +	125′ apart	6 per morgen	
r	200′ apart	2 per morgen	Rare.
vr	300′ and over apart	1 per morgen	

A capital letter used for the abundance symbol means that the plant concerned is conspicuous.

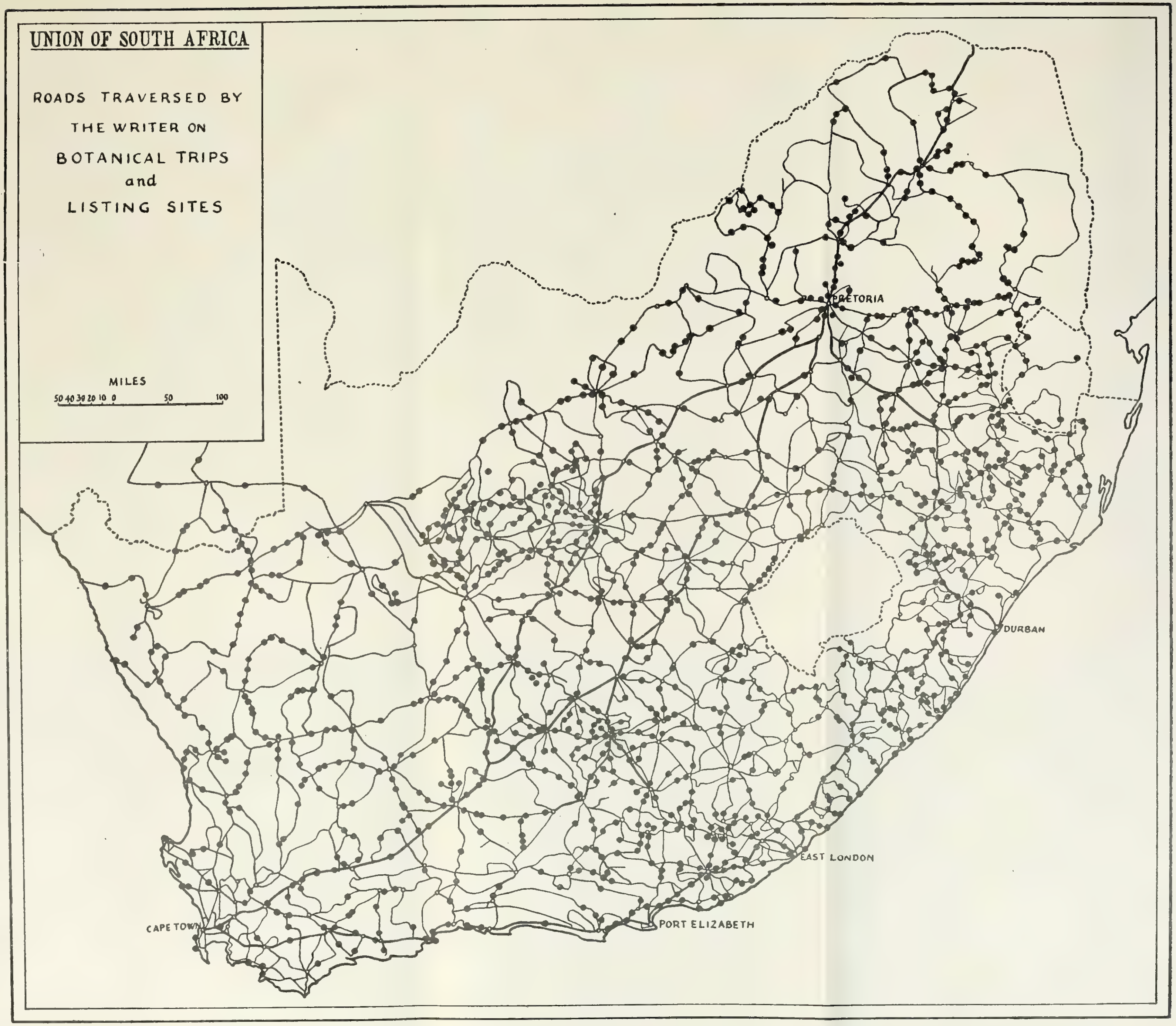
Habitat symbols:

l	= local	$^1/_{10}$
ll	= very local	$^1/_{100}$
lll	= extremely local	$^1/_{1000}$
.m	= at the margin of	$^1/_{10}$
.e	= on a krantz or rocky place	$^1/_{100}$
.w	= along a temporary watercourse	$^1/_{100}$
.W	= banks of a river	$^1/_{100}$
.p	= by the roadside	$^1/_{100}$
.P	= in the railway enclosure	$^1/_{100}$
.↑,↓	= upper slopes and lower slopes	$\frac{1}{2}$
.*	= abundance not recorded	
.bc	= in bush clumps	$\frac{1}{4}$
.E,W,N,S	= on E., W., N. or S. aspect	1, $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$
.a	= on termitaria	$^1/_{100}$
.t	= hiding under bushes	1
.T	= under trees	1
.h	= in a depression	$^1/_{100}$
.H	= in a pan	$^1/_{100}$
.V	= in a vlei	$^1/_{100}$
.k	= a small koppie	$^1/_{100}$

The arbitrary numerical values of the habitat symbols can be modified to suit individual lists.

This method can only be applied by one who has a thorough knowledge of the flora and if one meets a plant whose specific name is not known it must be collected and preserved for identification.

Having made a sufficient number of lists in each veld type (the more the better), one next proceeds to arrange all the species recorded in that veld type in alphabetical order. One then enters the abundance symbols in columns against their respective species. This enables one to see at a glance which species are of general occurrence throughout a veld type, and thus typical of it; but to enable one to arrange the species in order of numerical importance, it is necessary to substitute the numerical values of the symbols and find the average number per morgen of each species. It sometimes happens that a species will only occur in one or two lists, not being typical of the veld type; but being common in those few samples, will appear unduly important. To get over this difficulty, it is proposed to multiply this average number per morgen by the number of lists in which the particular species occurs and divide by the total number of lists, to give a figure which will be called the Relative Abundance. The higher the proportion of the lists in which the species occurs, the more nearly will the Relative Abundance be the same as the average number per morgen. It must be remembered that these figures are purely an estimate, and it has been observed that there is a tendency to over-estimate the spacing of the plants, so that they are likely to be a conservative estimate. Further, it takes many years to get to know every plant in the flora, so it is necessary


UNION OF SOUTH AFRICA
ROADS TRAVERSED BY
THE WRITER ON
BOTANICAL TRIPS
and
LISTING SITES
MILES
50 40 30 20 10 0
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PRETORIA
DURBAN
EAST LONDON
PORT ELIZABETH
CAPE TOWN

to define the Relative Abundance tables as " conservative estimates of the number of plants of each species to be expected per morgen in typical samples of the veld types, within the limits of the writer's knowledge of the flora ". Individual samples will show variations from the Relative Abundance table of the veld type, greater amongst the rarer and less readily recognizable species than amongst the common and permanently recognizable species.

It will have been noted that a sample of veld is " chosen "; that is, the samples are not random, and they cannot be, because the object has been not to describe the veld simply as it is to-day after 50–300 years of what we know now to have been, in varying degrees, grazing mismanagement, but to describe it as it could be in its most useful form. This does not usually mean the climax, because, as has been said, reversal of the succession to some extent is often necessary and usually desirable, to bring the vegetation to its most useful state; that being so, we can expect to find samples of veld which for various reasons are more or less in this state. The picture of the veld that will be drawn, therefore, will be better than the average, but it will give an idea of the goal of reclamation. At the same time, we shall pay much attention to the climax, because we cannot understand the veld unless we know the climax.

I.—COASTAL TROPICAL FOREST TYPES.

1. Coastal Forest and Thornveld.

The area shown as occupied by coastal forest is not all forest to-day, but in this area there can be no doubt that the whole area was naturally some form of forest. The veld to-day is a more or less open thornveld with numerous and extensive patches of forest. The grassveld constituent is rarely a pure, uniform grassveld, but is rather scrubby, full of tall herbs, shrubs and tall coarse grasses, showing how strong the successional movement towards forest is. The forest is mostly short (15 to 30 feet high), very dense and tangled, especially towards the coast; but against the seaward-facing hills further inland it becomes taller and less tangled, about 60 feet high, sometimes more. Its upper boundary is approximately the 1,500 foot contour northwards, dropping to about 1,000 feet southwards. It is evergreen, except for some of the largest trees in dry seasons (*Ficus natalensis*, *Calodendrum*, *Celtis* and *Erythrina caffra*).

Rainfall ranges from 35 to 60 inches per annum, i.e. nowhere insufficient for forest, but it comes in summer, so that the forest has to be of such a nature as to be able to endure a dry winter. Frosts are light, though they sometimes occur even on the Natal coast; summer temperatures are high yet less than at some places further inland or in the winter-rainfall area, but feel oppressive because of the usually high relative humidity. It is noticeable that whereas the short forests are hot and stuffy places, the high forests are fresh and cool, even chilly, in spite of being extremely damp, and they are capable of condensing surprising amounts of water from the mists.

The forests of the coast-belt can be divided into five types:—

(*a*) The typical forest in Natal and the Transkei.
(*b*) The Zululand palm-veld.
(*c*) The transitional type in the area between the Kei and Keiskama.
(*d*) The dune-forest, fairly uniform all along the coast.
(*e*) The Mangrove forest of the eastern coast.

(*a*) *The Typical Coast Belt Forest.*

(See Taljaard, Photo 120; King, Fig. 187, 288; Adamson, Photo 3.)

The commonest trees of general occurrence (i.e. occurring in 50 per cent or more of the samples) are:—

Millettia caffra	1,031	Casearia junodii	16
Protorhus longifolia	111	Trimeria grandifolia	15
Vepris lanceolata	65	Erythrina caffra	10
Combretum kraussii	62	Acacia karroo (at margin)	8
Rhus legati	39	Brachylaena discolor	7
Ficus natalensis	32	Cussonia spicata	7
Celtis kraussiana	27	Kiggelaria africana	6
Trichilia emetica	27	Canthium mundianum	5
Harpephyllum caffrum	22		

Trees of less general occurrence include:—

Syzygium cordatum	416	Chaetacme aristata	3
Strychnos henningsii	353	Cussonia sp	3
Strelitzia nicolai	263	Ekebergia meyeri	3
Erythroxylon pictum	165	Ficus capensis	3
Croton sylvaticus	41	Heywoodia lucens	3
Cryptocarya woodii	28	Millettia sutherlandii	3
C. latifolia	7	Mimusops marginata	3
Macaranga capensis	7	Olea foveolata	3
Ptaeroxylon obliquum	4	O. laurifolia	3
Trema guineensis	4	Podocarpus latifolius	3
Apodytes dimidiata	3	Rapanea melanophloeos	3
Cassine papillosa	3	Xymalos monospora	3
C. velutina	3	Cussonia umbellifera	2
Cassipourea verticillata	3	Albizzia gummifera	2

The high Relative Abundance of some of the less generally occurring species in this, and further lists, suggests that where these species occur they are important, and it indicates the great differences that one finds between different patches of forest.

Shrubs and climbers of general occurrence in the typical coastal forest are:—

Uvaria caffra	7,223	Clerodendrum glabrum	88
Dalbergia obovata	3,900	Fagara capensis	88
Tricalysia lanceolata	2,041	Dovyalis rhamnoides	65
Entada spicata	1,704	Grewia lasiocarpa	47
Cissampelos torulosa	1,531	Canthium ciliatum	44
Asparagus plumosus	1,493	Allophylus melanocarpus	34
Oricia bachmannii	1,035	Rhoicissus rhomboideus	25
Cissus fragilis	1,017	Helinus integrifolius	20
Senecio deltoideus	359	Asparagus virgatus	19
Grewia occidentalis	121	Carissa bispinosa	9
Flagellaria guineensis	114	Clausena anisata	7
Rhoicissus capensis	91		

Shrubs and climbers of less general occurence are very numerous; they include:—

Indigofera micrantha	1,439	Berkheya (Stobaea bipinnatifida)	364
Dioscorea dregeana	1,273	Trichocladus crinitus	346
Allophylus monophyllus	861	Maesa alnifolia	276
Smilax kraussiana	744	Royena simii	273
Sapium simii	727	Rubus rigidus	261
Acalypha glabrata	675	Vernonia mespilifolia	259
Conopharyngia ventricosa	675	Duvernoia adhatodioides	258
Notobuxus natalensis	497	Peddiea africana	249
N. macowanii	497	Cestrum laevigatum	166
Rhoicissus cuneifolius	457	Calpurnia sylvatica	83
Chrysophyllum natalense	434	Cassia sp	35
Burchellia bubalina	431	Gardenia neuberia	33
Cnestis natalensis	415	Gymnosporia harveyana	33
Dracaena hookeriama	415	Psychotria capensis	28
Dalbergia multijuga	390	Tarenna pavettoides	28

Small plants of the forest floor and margin of general occurrence are:—

Oplismenus hirtellus	193,808	Potamophila prehensilis	592
Acanthaceae (Phaulopsis, Isoglossa, Hypoestes)	42,487	Doryopteris concolor	551
Centella coriacea	19,454	Asparagus sp	523
Cyperus albostriatus	4,679	Setaria chevalieri	491
Plectranthus eckloni	1,047	Pellaea viridis	336
		Aneilema dregeanum	8

Of less general occurrence are:

Panicum maximum	4,802	Plectranthus laxiflorus	298
Stenotaphrum secundatum	4,606	Panicum sp. cf. laticomum	298
Dactyloctenium australe	3,421	Pellaea viridis var. macrophylla	274
Lapeyrousia cruenta	1,117	Miscanthidium capense	260
		Moraea iridioides	250
Achyranthes aspera	830	Stangeria eriopus	249
Hibiscus pendunculatus	775	Asplenium praemorsum	248
Justicia campylostemon	676	Desmodium scalpe	226
Sclerochiton harveyanus	675	Cyathula cylindrica	165
Dicliptera clinopodia	612	Panicum aequinerve	112
Asystasia gangetica	476	Stachys aethiopica	112
Cymbopogon validus	419	Anthericum sp	83

and many more.

The Relative Abundance table includes a total of 372 species.

The forests being small patches, the species of the margin are unduly important. The indicators of this forest are:—

Millettia caffra and *Protorhus longifolia* as dominants. If *Strelitzia nicolai*, *Croton sylvaticus*, *Macaranga capensis*, *Cussonia umbellifera* or *Syzygium cordatum* also occur, they will confirm it.

The more strictly tropical species are commoner northwards than they are southwards and with few exceptions do not cross the Great Kei River.

The thornveld which replaces this forest is scrubby, full of bush clumps, patches of forest and various stages in the succession between grassveld and forest; only rarely is it an open grassy savannah. The grass tends to be tall, consisting of tall forms of *Themeda triandra* and *Digitaria* spp., *Hyparrhenia filipendula* and other species, *Cymbopogon validus* and *C. excavatus*, as well as the usual shorter species of the warmer grasslands, e.g.:

Tristachya hispida.
Heteropogon contortus.
Loudetia simplex.
Paspalum commersonii var.
Eulalia villosa.
Andropogon amplectens.
Alloteropsis semialata var. ecklonii.
Eragrostis plana.
E. chalcantha.
Setaria sphacelata sub-sp. pyropea.
Panicum aequinerve.
Chloris gayana.

with a great variety of forbs and tall bushes, e.g.:

Hypoestes antennifera.
Tephrosia polystachya.
T. macropoda.
Cassia mimosoides.
Hewittia bicolor.
Cephalaria attenuata.
Lasiosiphon spp.
Lippia asperifolia.
Artemisia afra.
Pentanisia prunelloides.
Berkheya (Stobaea speciosa).
Indigofera eriocarpa and others.
Desmodium caffra and others.
Leonotis leonurus and others.
Eriosema squarrosum and others.
Nidorella auriculata
Pseudarthria hookeri.
Senecio serratuloides.

This scrubbiness would make the veld difficult to manage as purely grazing country, particularly as too heavy grazing encourages *Aristida junciformis* ('Ngongoni), which to-day is dominant over large areas; but the possibilities of growing pastures and fodder crops are so great that the veld is of minor importance in any farming system claiming to make full use of the potentialities of this area. The topography is steeply rolling, consisting of a maze of ridges between the numerous large and small rivers; rarely is there a rock out-crop and the soil is stable, so that soil erosion is, as yet, rarely to be seen, even though the natural vegetation has been entirely replaced by sugar-cane over large areas in Natal.

(*b*) *The Zululand Palm Veld.*

The Zululand palm veld, lying mainly north of the Tugela but with small outliers extending southwards past Durban, is associated with sandy soil on a badly drained coastal plain. The forest is rather a short, tangled jungle in which lianas, palms and *Strelitzia nicolai* are conspicuous, occurring in patches in a scrubby thornveld.

Important species in the jungle are:—

Brachylaena discolor.
Acacia mossambicensis.
Canthium mundianum.
Strelitzia nicolai.
Parinari mobola.
Kraussia floribunda.
Turraea floribunda.
Cussonia kraussii.
Dalbergia armata.
Empogona sp.
Hyphaene crinita.
Hippocratea sp.
Uvaria caffra.
Combretum gueinzii.
Phoenix reclinata.
Trichilia emetica.
Ficus stuhlmannii.
Cordia caffra.
Apodytes dimidiata.
Syzygium cordatum.

Ochna natalitia.
Clerodendrum glabrum.
Royena pallens.
Acacia karroo.
Scutia myrtina.
Clausena anisata.
Ziziphus mucronata.
Sclerocarya caffra.
Landolphia kirkii.
Gymnosporia senegalensis.
Spirostachys africanus.
Lachnopylis oppositifolia.
Euclea multiflora.
E. natalensis.
Xylotheca kotzei.
Albizzia gummifera.

with *Panicum maximum*, *P. deustum* and *Justicia flava*. In the somewhat drier inland fringe, *Euclea daphnoides E. undulata*, *Sarcostemma viminale*, *Acacia gillettiae*, *Dinocanthium hystrix*, *Euphorbia ingens*, *E. evansii*, *E. grandicornis*, *Strychnos innocua*, *Schotia brachypetala* and others may become important in a particularly dense and impenetrable form of this jungle. Where drainage is bad, the trees tend to adopt the habit of underground shrubs, with numerous shoots a few feet high, e.g. *Parinari mobola*. The vegetation of the swampy parts is an open, grassy palm-veld, mainly *Hyphaene crinita*.

The thornveld is usually open, with a dense, tall, scrubby grassveld consisting of:—

Themeda triandra.
Tristachya hispida.
Andropogon amplectens.
Imperata cylindrica.
Digitaria sp.
Eragrostis superba.
E. capensis.
Perotis indica.
Sporobolus nitens.
Heteropogon contortus.
Eragrostis plana.
Helichrysum kraussii.
Cymbopogon validus.
C. plurinodis.
Eragrostis sp. of E. nebulosa.
Hyparrhenia spp.
Euphorbia vandermerwei.
Brachiaria serrata.
Elyonurus argenteus.
Sphenostylis marginata.
Pachystigma venosum.
Dolichos axillaris.
Aristida junciformis (sometimes) and much besides, a rich flora.

Little information is available about this veld.

(*c*) *Transitional Coastal Forest.*

Transitional coastal forest between the Kei and the Keiskama: this is very similar to the drier parts of the typical forest except that it lacks such species as *Macaranga capensis*, *Croton sylvaticus* and *Cussonia umbellifera*, while *Ptaeroxylon*, *Schotia* spp. *Cassine* spp. and *Euphorbia grandidens* tend to be more common and *Euphorbia triangularis* sometimes occurs, showing that it is transitional to the drier Alexandria Forest. The thornveld which replaces it is very similar to the Eastern Cape Province Thornveld (No. 7, p. —), but with such tropical species as *Dalbergia obovata* playing an important part. [See Adamson, Photo 8 (Thornveld).]

(*d*) *The Dune Forest.*

This occupies a narrow belt on the row of high dunes running down the east coast, stunted on the seaward side, taller, up to 30 feet, on the landward side. More of it survives than of any of the other forest types. If we include the flora of the beach and the mud-flats of the numerous estuaries, this becomes a particularly interesting forest ecologically, and it is hoped in the future to examine it more thoroughly than has hitherto been done. It has not been studied north of Isipingo nor south of Kariega

Mouth. [See Marloth IV, Fig. 50; III, 1, Fig. 52A; II, 2, Fig. 147 (Thornveld); Reynolds, Pl. 70.]

The principal trees of general occurrence are:—

Mimusops caffra........	3,022
Euclea natalensis........	2,324
Canthium obovatum....	1,110
Apodytes dimidiata......	642
Brachylaena discolor....	267
Strelitzia nicolai........	94
Sideroxylon inerme.....	71
Tarchonanthus camphoratus	66
Scolopia zeyheri........	46
Ficus burtt davyi.......	36

Tree of less general occurrence are:—

Canthium mundianum...	847
Cassine sphaerophylla...	517
Phoenix reclinata........	190
Acacia karroo..........	47
Deinbollia oblongifolia..	25
Olea foveolata..........	20
Trichilia emetica........	20
Euphorbia triangularis...	16
Schotia brachypetala....	8
Pterocelastrus tricuspidatus	7
Euclea multiflora........	6
Hyphaene crinita (northwards)	6
Strychnos spinosa.......	6
Cordia caffra...........	5
Hippobromus pauciflorus	5
Ziziphus mucronata....	4
Harpephyllum caffrum..	3
Millettia caffra.........	2
Erythrina caffra.........	2
Ficus capensis..........	2
F. natalensis...........	1
Albizzia gummifera (northwards)	1

The generally occurring shrubs and climbers in the Dune Forest are:—

Scutia myrtina..........	8,875
Allophylus erosus.......	3,872
Dracaena hookeriana....	3,288
Eugenia capensis........	2,404
Cynanchum ellipticum...	2,068
Turraea obtusifolia......	1,645
Salacia kraussii.........	1,252
Rhus sp. = A. 13250....	1,026
Fagara capensis.........	1,006
Rhoicissus digitatus.....	849
Putterlickia verrucosa....	690
Dolichos lablab.........	666
Chrysanthemoides monilifera	440
Secamone alpini........	97
Clerodendrum glabrum.	86
Grewia occidentalis....	72
Dalbergia obovata......	64
Passerina rigida.........	52
Psidium guajava........	41
Rhoicissus cuneifolius...	36
Cotyledon orbiculata....	30
Clausena anisata........	7

while the less generally occurring shrubs and climbers include:—

Rhynchosia caribaea.....	684
Rhus simii..............	506
Flagellaria guineensis....	488
Ipomoea cairica.........	488
Pavetta lanceolata.......	471
Solanum geniculatum....	471
Asparagus falcatus......	470
Cassine tetragona var. laxa	328
Glycine javanica........	313
Senecio pterophorus.....	313
Psychotria capensis......	191
Smilax kraussiana.......	169
Dovyalis rhamnoides....	168
Allophylus monophyllus	156
Behnia reticulata........	156
Berkheya (Stobaea bipinnatifida)	156
Pyrenacantha scandens..	156
Vernonia angulifolia....	156
Ctenomeria capensis....	151
Rhus crenata...........	99
Metalasia muricata......	97
and many more.	

It will be seen that lianas are less important in this forest, which is what one would expect.

Plants of the forest floor and margin include:—

Dactyloctenium australe	106,509	Gloriosa superba.......	876
Ehrharta erecta........	33,109	Panicum deustum.......	719
Acanthaceae...........	21,263	Mariscus dregeanus.....	667
Oplismenus hirtellus....	17,213	Rubia cordifolia........	94
Anystasia gangetica....	8,450	Mariscus sieberianus....	
Commelina benghalensis	6,538	Cissus fragilis..........	55
Panicum maximum.....	6,273	Kalanchoe rotundifolia..	27
Pupalia atropurpurea..	5,797	Senecio deltoideus......	7
Achyranthes aspera....	4,275		

The total number of species in the Relative Abundance Table is 342.

The lower edge of this forest, on the seaward side, usually consists of pioneer stages where the dunes face directly on to the beach:—

(1) *Chrysanthemoides monilifera*, *Metalasia muricata*, *Passerina rigida* on half stabilized dunes.

(2) *Mariscus congestus*, *Sporobolus virginicus*, *Scaevola thunbergii*, *Ipomoea pes-caprae* and other trailing and stoloniferous plants, on recently formed dunes.

(3) *Gazania uniflora*, *Arctotheca nivea* and *Cnidium suffruticosum* at the edge of the beach.

Where the coast is rocky, the forest will come right down to high-tide level.

The scrubby thornveld which replaces this dune-forest includes a number of species of Fynbos affinity, e.g. *Aristida capensis*, *Ehrharta calycina*, *Ficinia lateralis*, *Restio* sp., *Metalasia muricata* and *Chrysanthemoides monilifera*, especially southwards and on loose, disturbed sand. On the whole, however, it is sub-tropical, dominated by *Themeda triandra* with much *Digitaria littoralis*. Other important species are:—

Andropogon amplectens.
Argyrolobium rupestre.
Aristida junciformis (sometimes).
Aster erigeroides.
Brachiaria serrata.
Centella coriacea.
Chaetacanthus setiger.
Cymbopogon marginatus.
Cynodon dactylon.
Elyonurus argenteus.
Eragrostis chloromelas.
Eriosema squarrosum.
Eulalia villosa.
Helichrysum spp.
Imperata cylindrica.
Indigofera spp.
Lasiosiphon anthylloides,
L. macropetalus.
Lobelia scabra.
Monsonia ovata.
Paspalum commersonii var.
Polycarena cuneifolia.
Sacciolepis curvata.
Setaria sphacelata.
Sporobolus capensis.
Stenotaphrum secundatum.
Tephrosia macropoda.
Trachypogon capensis.
Tristachya hispida.

The indicators of the Dune-forest are *Mimusops caffra* and *Allophylus erosus*.

(*e*) *The Mangrove Forests.*

The Mangrove Forests have not been studied at all in the course of this survey so far. They are well developed at Durban and do not extend much further south, except as temporary patches at the mouths of rivers where suitable mud-flats occur, e.g. at Bashee Mouth. Typical trees are the Mangroves, *Avicennia marina*, *Bruguiera gymnorhiza* and *Rhizophora mucronata*, and *Hibiscus tiliaceus*. (See Marloth II, 2, Fig. 141B; Taljaard, Photo 121.)

2. The Alexandria Forest.

This is the south-westward extension of the coastal tropical forest into the divisions of Peddie, Bathurst, Alexandria and Port Elizabeth, reaching its best development in Alexandria, where, also, the biggest areas of it survive. The rainfall is smaller (25–30 inches per annum), but is better distributed, a good proportion of it falling in winter. On the other hand, this dispersion through the year of a moderate rainfall makes droughts felt more severely, so that the forest is of a decidedly more xerophytic type than is that to the north-east of the Keiskama River. It links the latter, by easy transitions, with the Addo Bush.

The Alexandria Forest, in general, is a short (30 feet), very dense forest; it is said that the best parts of it are high forest, but these have not been seen, and no data about them are available. So far as this survey goes, the principal trees of general occurrence are:—

Cassine sphaerophylla.....	962	Ficus burtt-davyi........	26
Ochna arborea..........	785	Scolopia zeyheri........	17
Apodytes dimidiata.....	664	Harpephyllum caffrum..	16
Cassine aethiopica.......	168	Acacia karroo..........	15
Sideroxylon inerme......	147	Allophylus decipiens....	14
Euclea undulata.........	77	Euclea daphnoides......	11
Olea woodiana..........	68	Cussonia spicata........	7
O. africana.............	52	Cassine crocea..........	5
O. foveolata............	39	Hippobromus pauciflorus	5
Ptaeroxylon obliquum...	30		

Trees of less general occurence are:—

Euclea natalensis........	472	Cassine kraussiana......	14
Pittosporum viridiflorum	314	Trichocladus ellipticus..	10
Rapanea melanophloeos.	157	Canthium obovatum....	6
Strychnos decussata.....	156	Curtisia faginea.........	6
Pterocelastrus tricuspidatus	144	Olinia cymosa..........	6
Schotia latifolia.........	116	O. emarginata..........	6
Gymnosporia undata....	38	Tarchonanthus camphoratus	3
Schotia speciosa.........	32	Oricia bachmannii......	2
Cordia caffra...........	21	Vepris lanceolata.......	2
Canthium ventosum.....	14	Brachylaena discolor....	1

In this short forest, shrubs are particularly important, many of them being scramblers; of general occurrence are:—

Scutia myrtina..........	7,675	Rhus lucida............	143
Azima tetracantha.......	5,469	Gymnosporia buxifolia..	116
Grewia occidentalis......	3,139	Rhoicissus cirrhiflorus..	103
Rhoiacarpos capensis....	3,128	Asparagus medeoloides.	99
Capparis citrifolia.......	2,888	Croton rivularis........	75
Plumbago capensis......	2,854	Pavonia praemorsa......	71
Cynanchum ellipticum...	2,432	Rhus refracta...........	70
Behnia reticulata........	1,291	Cotyledon velutina......	69
Clausena anisata........	1,269	Pelargonium peltatum...	67
Dovyalis rhamnoides....	1,023	Ehretia rigida..........	63

Fagara capensis	925	Asparagus plumosus	40
Rhoicissus digitata	875	Sarcostemma viminale	34
Rhus longispina	818	Royena decidua	26
Secamone frutescens	818	Tecomaria capensis	26
Rhus incisa	789	Rhoicissus capensis	11
Carissa bispinosa	787	Acokanthera venenata	9
Canthium spinosum	738	Capparis zeyheri	7
Asparagus multiflorus	691	Maerua triphylla	7
Royena villosa	663	Viscum obscurum	6
Jasminum angulare	627	Capparis rudatisii	5
Cussonia thyrsiflora	338		

Of less general occurrence are:—

Cassine tetragona var. laxa	489	Senecio deltoideus	25
Putterlickia pyracantha	488	Chrysanthemoides monilifera	17
Clematis sp.	471	Eugenia capensis	16
Asparagus racemosus	320	Pavetta spp.	14
Senecio brachypodus	314	Senecio macroglossus	14
Secamone alpini	313	Psychotria capensis	7
Rhoicissus cuneifolius	159	Allophylus erosus	6
Euclea racemosa	156	Aloe speciosa	6
Olea exasperata	156	Rhamnus prinoides	6
Clerodendrum glabrum	31		

and many more.

The undergrowth includes:—

Acanthaceae, various	104,310	Euphorbia kraussiana	43
Panicum deustum	4,875	Exomis microphyllum	10
Sansevieria sp.	179		

with the following, and many more, less general:—

Plectranthus hirtus	740	Panicum maximum	325
Cyperus albostriatus	471	Achyranthes aspera	156
Stipa dregeana	471	Asparagus oxyacanthus	156

The total number of species in the Relative Abundance Table is 259.

This part of the coastal belt is less steeply rolling than that to the north-east, except in the eastern part of the Alexandria division, where the valleys are deep and rocky; here the easy transition from Alexandria Forest to Valley Bushveld is well seen. The broad belt of dunes between the sea and the hills in the Alexandria division provides an interesting transition from the Dune Forest to the Alexandria Forest, but it has still to be studied. Towards Kenkelbosch the transition to Addo Bush can be seen; in these drier parts the forest is replaced by a fairly dense *Acacia karroo*-thornveld, whereas in the wetter parts, e.g. west of Port Alfred, it tends to be replaced by an almost pure grassveld. This grassveld is similar to that of the Kei-Keiskama transitional area, but has more species of Fynbos affinity, which, in the sandier parts, are quite important and likely to become more important.

As in the rest of the coastal belt, the soils are stable, and the same remarks about utilization apply. Under the drier conditions, however, the margin of safety is likely to be narrower, so that few liberties can be taken with the soil.

3. THE PONDOLAND COASTAL PLATEAU SOURVELD.

This veld type occupies a plateau, at an elevation of 1,000–1,500 feet above the sea, rising steeply from the coast, and deeply broken and indented by forest-filled gorges. The escarpment is forest-clothed, tropical at the coast, but sub-tropical on the upper slopes and showing an affinity with the Knysna Forest. The Plateau itself is grassveld, very dense and vigorous, but on the Table Mountain sandstone of this plateau, under conditions of high summer rainfall (45 to over 50 inches per annum), it is very sour. The forests are mainly to be found in protected places—the escarpment, the gorges, and little valleys below krantzes, but are less strictly confined to such places than are the forests of higher altitudes.

It is high forest, differing from the coastal forest mainly in the presence, in an important role, of *Podocarpus latifolius*; generally occurring trees are:—

Strelitzia nicolai	1,213	Cassipourea verticillata	18
Protorhus longifolia	254	Podocarpus latifolius	18
Cussonia umbellifera	247	Trichilia emetica	18
Trimeria grandifolia	103	Syzygium cordatum	17
Croton sylvaticus	76	Xymalos monospora	12
Ficus burtt-davyi	76	Cussonia spicata	9
Ilex mitis	74	Ekebergia meyeri	9
Combretum kraussii	57	Millettia caffra	9
Syzygium gerrardii	57	Gardenia globosa	6
Trema guineensis	57	Loxostylis alata	6
Sapium mannianum	53	Cryptocarya woodii	5
Ficus natalensis	49	Scolopia ecklonii	5
Macaranga capensis	23	Bersama tysoniana	1
Apodytes dimidiata	18	Canthium mundianum	1

Less generally occurring trees are:—

Hippobromus pauciflorus	400	Oricia bachmannii	6
Brachylaena discolor	81	Cassine velutina	3
Millettia sutherlandii	64	Celtis kraussiana	3
Vepris lanceolata	35	Cryptocarya latifolia	3
Lachnopylis floribunda	32	Ficus ingens	3
Rhus legati	32	Gymnosporia pendunlaris	3
Rapanea melanophloeos	22		
Chaetacme aristata	16	Halleria lucida	3
Ficus capensis	16	Mimusops obovata	3
Gardenia capensis	16	Pittosporum viridiflorum	3
Fagara davyi	6	Podocarpus falcatus	3
		Rauvolfia caffra	3

Generally occurring shrubs and climbers are:—

Uvaria caffra	7,008	Cnestis natalensis	57
Smilax kraussiana	6,400	Indigofera natalensis	57
Dalbergia obovata	4,240	Rhoicissus rhomboideus	57
Flagellaria guineensis	4,022	Psychotria capensis	49
Potamophila prehensilis	2,448	Asparagus sp	35
Burchellia bubalina	2,281	Behnia reticulata	13
Royena villosa	2,176	Cryptocarya wyliei	10
Secamone alpini	1,734	Rhoicissus cuneifolius	10
Grewia lasiocarpa	1,612	Noltia africana	7
Cissampelos torulosa	1,252	Royena cordata	5

Peddiea africana	1,252
Dioscorea cotinifolia	1,209
Pavetta bowkeri	1,205
Cassinopsis tinifolia	125
Ctenomeria capensis	100
Clerodendron glabrum	72
Cissus fragilis	57
Rhus lucida	3
Chrysanthemoides monilifera	1
Crotalaria capensis	1

Less generally occurring shrubs and climbers include:—

Entada spicata	803
Rubus sp.	803
Carissa bispinosa	800
Helinus integrifolius	400
Tecomaria capensis	400
Tragia natalensis	400
Tricalysia lanceolata	400
Allophylus monophyllus	129
and many more.	
Solanum auriculatum	83
Rhoicissus capensis	81
Dracaena hookeriana	64
Acacia ataxacantha	40
Hippocratea sp.	40
Adenia gummifera	35
Dioscorea dregeana	35
Grewia occidentalis	35
Ceropegia implicata	23

Of general occurrence in the undergrowth of the forest-floor and margin are:—

Acanthaceae (various)	28,880
Lobelia patula	13,922
Cyperus albostriatus	4,365
Setaria chevalieri	947
Cluytia pulchella	121
Aneilema aequinoctiale	40
Viscum nervosum	9
Senecio rhyncholaenus	8
Oldenlandia natalensis	6

with the following of less general occurrence:—

Oplismenus hirtellus	31,680
Plectranthus ciliatus	1,440
Glycine javanica	803
Dactyloctenium australe	334
Blechnum australe	289
Commelina benghalensis	230
Leersia hexandra	144
Panicum chusquioides	144
Sporobolus subtilis	144
Panicum maximum	126
Ischaemum arcuatum	75
Aeolanthus parvifolius	67

The total number of species in the Relative Abundance Table is 351.

The Pondoland Plateau Sourveld itself is the densest veld in the Union, so dense that the grasses grow as single shoots rather than as tufts; at least the tufts are very small. The species of general occurrence are:—

Themeda triandra	729,673
Tristachya hispida	720,000
Andropogon filifolius	489,600
Trachypogon capensis	439,200
Andropogon amplectens	380,867
Monocymbium ceresiiforme	121,111
Eulalia villosa	103,973
Cyperus compactus	102,833
Heteropogon contortus	86,422
Eragrostis chalcantha	60,833
Alloteropsis semialata var. ecklonii	47,556
Eragrostis capensis	41,119
Aristida junciformis	19,919
Loudetia simplex	19,204
Desmodium caffra	1,670
Dierama reynoldsii	1,670
Thunbergia atriplicifolia	1,556
Cymbopogon validus	1,443
Fadogia sp.	1,163
Anthospermum sp. =A. 10677	1,160
Helichrysum adscendens	870
Panicum natalense	839
Setaria sphacelata subsp. pyropea	839
Lasiosiphon kraussianus	837
Watsonia densiflora	837
Cyphia elata	834
Spermacoce natalensis	97
Panicum aequinerve	72

Acalypha peduncularis	9,733
Digitaria diagonalis	9,733
Paspalum commersonii var.	8,082
Restio sp.	4,800
Pentanisia prunelloides	4,713
Tephrosia macropoda	4,278
Rhynchosia totta	3,418
Scilla rigidifolia	3,378
Digitaria sp.	3,000
Helichrysum appendiculatum	1,924
Centella glabrata var. natalensis	70
C. coriacea	41
Euphorbia epicyparissias	40
Hybanthus thymifolium	39
Ctenium concinnum	12
Muraltia pilosa	5
Heliophila rigidiuscula	3
Osteospermum imbricatum sub. sp. nervatum	1
Rhus discolor	1

Of less general occurrence are:—

Cassia mimosoides	24,825
Schoenoxiphium sp.	3,756
Ficinia sp.	1,600
Eriosema squarrosum	1,160
Becium obovatum	1,111
Berkheya (Stobaea speciosa)	1,111
Indigofera hilaris	1,111
Eugenia albanensis	611
Panicum dregeanum	563
Xyris anceps	559
Acalypha depressinervia	558
Hypoxis rigidula	558
Indigofera rostrata	558

and many more, the total number of species in the Relative Abundance Table being 211.

This is a particularly well-mixed veld, with no one species overwhelmingly dominant, but very sour. Most of it seems to be scarcely grazed at all, probably owing to its sourness; where it is grazed, it tends to become dominated by, and largely replaced by, *Aristida junciformis*.

The regular occurrence of *Podocarpus*, *Loxostylis*, *Restio*, *Muraltia*, *Noltia*, *Rhus lucida*, *Chrysanthemoides* and *Centella glabrata* var. *natalensis* is interesting, as showing a link with the Fynbos and the Knysna Forest; further, among the rarer plants occur also *Leucadendron eucalyptifolium*, *Lobelia coronopifolia*, *Roella glomerata*, *Protea flanaganii*, *Gnidia myrtifolia*, *Aspalathus laricifolia*, *A. setacea*, *Stoebe vulgaris*, *Agathosma ovata*, *Festuca costata*, *Protea caffra*, *P. rouppelliae*, *Relhania pungens*, *Schizaea tenella*, *Athanasia leucoclada*, *Cliffortia strobilifera*, *Philippia evansii* and *Phylica paniculata*, all of Fynbos affinity. On the other hand, in *Loudetias implex*, *Ctenium concinnum* and *Schizachyrium semiberbe* we have an interesting link with the high altitude sour grassveld types of the Transvaal.

The indicators of this veld type are *Podocarpus latifolius* in association with *Protorhus*, *Cussonia umbellifera*, *Croton sylvaticus* and *Macaranga*.

Outliers occur on The Heads at Port St. John's, here the fynbos elements are particularly conspicuous.

The Pondoland Plateau Sourveld could be one of the most productive parts of the Union; at present its potentialities are completely wasted. The stages in the Reversed Succession have not been established in detail, but appear to be of the usual type:—

(1) High Forest (the Climax).
(2) Short Forest.
(3) Scrubby, tall, sour grassveld.
(4) Short sour grassveld (the Optimum Stage).
(5) 'Ngongoni Veld (the Critical, and lowest, stage).

4. The Knysna Forest.

(See Marloth I, Pl. 13; III, 1, Pl. 19, 30; Adamson, Photo 4.)

This forest has been little studied during this survey, because it has already been exhaustively described by J. Phillips, Forest Succession and Ecology in the Knysna Region, Botanical Survey Memoir No. 14 (1931). It should be pointed out, however, that it is probable that the importance of the Fynbos in the Succession to forest is largely (though not entirely) the result of careless exploitation; that the agriculturally useful sub-tropical grassveld would have been far more important under conditions of wise and knowledgeable exploitation than the agriculturally useless Fynbos is to-day. This region of high, well distributed rainfall, sour sandy soils and vigorous vegetation is, like the Pondoland Plateau, one whose agricultural potentialities have scarcely been touched.

5. The 'Ngongoni Veld.

(See Taljaard, Photos 114, 118; King, Figs. 11, 190.)

This veld type, together with the Eastern Province Thornveld and the Zululand Thornveld, occupies a narrow and irregular belt of rolling country just above the Coastal Forest belt. It lies on the slopes of the escarpment of the lowest of the series of plateaux of which South Africa is made up, and, lying between c.1,500 and 3,000 feet above the sea, is a good deal cooler and less humid than the coast-belt. The rainfall ranges from 30 to 50 inches per annum, and the natural vegetation would have been forest and scrub-forest of tropical affinity, but lacking, as important constituents, the species of more essentially tropical nature. At lower levels it is, like the coast-belt, intersected by numerous bush-filled river valleys, itself occupying the ridges, but at the higher levels it tends to occupy the valleys, at least of the shorter rivers, the Highland Sourveld, Dohne Sourveld and Natal Mistbelt 'Ngongoni veld occupying the ridges. What chiefly distinguishes it from the Zululand Thornveld to the north and the Eastern Province Thornveld to the south-west is the fact that the sour grassveld, which has almost completely replaced the forest, has become dominated by the 'Ngongoni (*Aristida junciformis*), almost to the exclusion of other grasses. Why this should be so is not at all clear, particularly as this grass is able to grow in the latter veld types. The only other place where the 'Ngongoni has been observed to become similarly dominant is a few square miles around Swellendam.

The surviving forests include the important Nkandhla, 'Qudeni and Weza forests, all near the upper edge of the veld type, except that the 'Qudeni forest extends down into the Tugela valley to about 1,500 feet. The lower part of the forest, however, was not included in the sample. It must not be thought that this veld has become treeless; on the contrary, exotic wattles have been entensively planted.

The trees of general occurrence in the forests of the 'Ngongoni veld are:—

Trimeria grandifolia.....	1,356	Harpephyllum caffrum..	25
Combretum kraussii.....	1,277	Kiggelaria africana......	25
Rapanea melanophloeos.	981	Pittosporum viridiflorum	17
Cryptocarya woodii.....	496	Rhus legati.............	10
Xymalos monospora.....	217	Bersama tysoniana......	8

Halleria lucida..........	65	Celtis kraussiana........	5
Cussonia spicata........	25	Calodendrum capense...	5

Trees of less general occurrence are:—

Apodytes dimidiata......	310	Gardenia globosa.......	7
Syzygium cordatum.....	92	Scolopia zeyheri.........	7
Scolopia flanaganii......	51	Cunonia capensis.......	6
Garcinia gerrardii.......	44	Ocotea bullata..........	4
Syzygium gerrardtii.....	29	Oricia bachmannii......	4
Olea laurifolia..........	17	Cussonia umbellifera....	4
Scolopia mundtii........	17	Seemannaralia gerrardii.	4
Vepris lanceolata........	17	Trichilia emetica........	4
Trichocladus ellipticus...	16	Fagara davyi...........	4
Podocarpus latifolius....	13	Gardenia capensis......	3
Allophylus decipiens.....	7	Olea woodiana.........	3

and many more, including as rareties *Macaranga*, *Ficus natalensis*, *Protorhus*, *Trema*, *Albizzia gummifera*, *Casearia junodii* and *Croton sylvaticus* amongst the tropical species, and *Podocarpus falcatus* and *P. henkelii* amongst the southern species.

Generally occurring shrubs and climbers are:—

Uvaria caffra...........	3,604	Burchellia bubalina.....	81
Andrachne ovalis........	3,529	Senecio panduraefolius..	76
Senecio deltoideus.......	2,816	Scutia myrtina..........	73
Cissampelos torulosa....	2,319	Cassine tetragona var. laxa	69
Gymnosporia harveyana.	2,183		
Clausena anisata........	1,466	Secamone alpini........	61
Canthium ciliatum......	1,326	Entada spicata..........	39
Strophanthus speciosus..	1,230	Grewia lasiocarpa.......	32
Dalbergia obovata.......	1,084	Helinus integrifolius.....	28
Behnia reticulata........	963	Calpurnia sylvatica......	21
Vernonia mespilifolia....	836	Psychotria capensis.....	21
Allophylus monophyllus.	747	Rhoicissus capensis.....	21
Dioscorea dregeana.....	733	Carissa bispinosa.......	9
Rhoicissus rhomboideus.	720	Osyridocarpus natalensis	7
Rubus sp..............	568	Gymnosporia buxifolia..	6
Rhoicissus cuneifolius...	504	Cassinopsis tinifolia.....	5
Grewia occidentalis.....	501	Heteromorpha trifoliata.	5
Rubus sp..............	403		

Less generally occuring shrubs and climbers include:—

Peddiea africana........	973	Euclea natalensis........	154
Stephania abyssinica var. tomentella	888	Dalbergia multijuga.....	113
		Gymnosporia nemorosa.	106
Pavetta kotzei...........	531	Buddleja pulchella......	102
Senecio tamoides........	531	Rinorea natalensis......	102
Jasminum stenolobum...	417	Riocreuxia torulosa.....	102
Asparagus plumosus....	323	Smilax kraussiana.......	102
Royena villosa..........	323	Tecomaria capensis.....	102
Dovyalis rhamnoides....	320	Oxyanthus gerrardii.....	53
Maesa lanceolata........	287	Pavetta bowkeri........	53
Buddleja dysophylla.....	282	Cnestis natalensis.......	51
Clematis brachiata.......	277	Flagellaria guineensis....	51
Tricalysia lanceolata.....	259	Gymnosporia cordata...	51

Senecio mikanioides	213	G. rubra	51
Mackaya bella	204	Maesa alnifolia	49

Generally occurring plants of the forest-floor and margin are:—

Hypoestes verticillaris and other Acanthaceae	61,776	Pteris biaurita	1,052
Oplismenus hirtellus	53,200	Pteridium aquilinum	621
Plectranthus laxiflorus	30,427	Miscanthidium capense	569
Cyperus albostriatus	6,405	Blechnum attenuatum	368
Galopina circaeoides	4,224	Rubia cordifolia	33
Selaginella kraussiana	4,145	Helichrysum nudifolium var. quinquenerve	31
Pellaea viridis	4,042	Schistostephium rotundifolium	31
Moraea iridioides	1,786		

while the following, and many others, are of less general occurrence:—

Potamophila prehensilis	11,164	Streptocarpus rexii	598
Setaria chevalieri	10,277	Euphorbia kraussiana	514
Panicum aequinerve	2,645	Polystichum luctuosum	512
Ehrharta erecta	2,497	Polypodium polypodioides	404
Centella coriacea	1,734	Mohria caffrorum	388
Hypolepis bergiana	1,592	Asplenium adiantum-nigrum v. obtusum	320
Plectranthus ecklonii	1,236	Asparagus virgatus	268
Osteospermum herbaceum O. grandidentatum	1,185	Nidorella auriculata	109
Fleurya mitis	906	Oldenlandia natalensis	95
Plectranthus ciliatus	735	Cluytia pulchella	78
Asplenium praemorsum	661	C. hirsuta	66
Anthospermum lanceolatum	654	Leonotis leonurus	41
Cymbopogon validus	646	Cissus woodii	7
		Athrixia phylicoides	4

The ferns are of greater importance here than in the Coastal Forest, and include the tree-ferns *Cyathea dregei* 1, *Hemitelia capensis* 5, *Lonchitis pubescens* 5, and *Marattia fraxinea* 5; while the palms and *Strelitzia* have fallen out and *Dracaena* 12 has become rare.

The indicators of this forest are *Combretum kraussii* as dominant with *Trimeria grandifolia*, *Rapanea*, *Cryptocarva woodii* and *Xymalos monospora*.

The number of species in the Relative Abundance Table is 446.

Although selected samples of the thornveld which replaces this forest show it to be a well-mixed *Themeda*-dominated sourveld, it must be remembered that, to-day, by far the greater part of the area is completely dominated by *Aristida junciformis*, for which reason it has been named the 'Ngongoni Veld. This thornveld is generally very open, except at the edges of the bush-filled valleys.

Generally occurring species in well preserved samples are:—

Themeda triandra	1,170,000	Eragrostis robusta	3,965
Tristachya hispida	310,091	Pentanisia prunelloides	2,406
Heteropogon contortus	241,650	Tephrosia macropoda	1,991
Trachypogon capensis	143,325	Eriosema squarrosum	1,900
Andropogon amplectens	132,913	Acalypha peduncularis	1,656
Eragrostis plana	46,105	Cassia mimosoides	1,628
E. chalcantha	38,688	Aster bakerianus	1,599
Aristida junciformis	29,717	Vernonia natalensis	1,277

Monocymbium ceresiiforme	23,015
Alloteropsis semialata var. ecklonii	14,839
Sporobolus capensis	11,739
Eulalia villosa	8,675
Eragrostis capensis	8,450
Hyparrhenia hirta	8,015
Spermacoce natalensis	6,143
Paspalum commersonii var.	4,502
Andropogon schirensis	1,255
Zornia tetraphylla	849
Digitaria diagonalis	821
Berkheya setifera	677
Thunbergia atriplicifolia	677
Centella coriacea	454
Cymbopogon validus	300
Indigofera rostrata	77
Oldenlandia amatymbica	17
Gladiolus ecklonii	7
Cephalaria attenuata	5

while the following are of less general occurrence:—

Andropogon appendiculatus	6,961
Indigofera hilaris	3,170
Setaria sphacelata	2,703
Andropogon filifolius	2,112
Brachiaria serrata	2,112
Microchloa caffra	1,801
Becium obovatum	939
Euphorbia striata	938
Panicum aequinerve	938
Pteridium aquilinum	739
Acalypha depressinervia	489
Rhynchosia effusa var. cooperi	489
R. totta	489
Adhatoda andromeda	471
Harpechloa falx	471
Miscanthidium capense	270
Watsonia densiflora	68
Crabbea hirsuta	41
Alysicarpus violaceus	21
Commelina africana	21
Cymbopogon excavatus	21
Hypericum sonderi	21
Vigna galpinii	21
Oldenlandia natalensis	20
Sebaea schoenlandii	5
Sonchus dregeanus	3
Anthospermum rigidum	2
Pellaea viridis	2
Polygala hottentota	2

and many more, the total number of species in the Relative Abundance Table being 257.

This veld type, with its fairly good rainfall, is also capable of intensification in part; but on the poorer soils in Natal, Pentz considers it to be suitable only for semi-intensive farming. Growth is not so vigorous that the critical stage cannot be passed, as is evidenced by the soil erosion in certain parts, e.g. Nkandhla, Ndwedwe and Umzimkulu.

6. ZULULAND THORNVELD.

Like the 'Ngongoni veld, this veld type occupies the escarpment of the first plateau, as well as the top and upper east slopes of the Lebombo Range, and although the rainfall is somewhat less (25–40 inches per annum, mostly 30–35 inches) it was probably also forest and scrub-forest in its original condition. It shows a strong bushveld affinity and is to be regarded as a transition from the 'Ngongoni veld to the Lowveld Sour Bushveld and Lowveld.

The Zululand Thornveld has a greater altitudinal range, from about 500 to about 3,500 feet above the sea, so that it is easy to recognize two forms of it—

(*a*) The low-altitude form, up to about 1,500 feet, which, besides having a hotter climate, is generally somewhat drier.

(*b*) The high-altitude form.

It is Form (*b*) which corresponds to the 'Ngongoni veld, Form (*a*) corresponding rather to the upper part of the coastal belt further south, but differing in that it is to-day for the most part bushveld rather than thornveld.

Form (*a*).—(See Reynolds, Pl. 76.) The original forest is of distinctly tropical type with such species as:—

Rauvolfia caffra.
Protorhus longifolia.
Trichilia emetica.
Combretum kraussii.
Macaranga capensis.
Croton sylvaticus.
Ekebergia meyeri.
Cussonia umbellifera.
Albizzia gummifera.
Pygeum africanum.
Trema guineensis.
Ficus capensis.
F. natalensis.
F. sycomorus.
Erythrina caffra.
Syzygium cordatum.
S. gerrardii.
Phoenix reclinata.
Hyphaene crinita.
Uvaria caffra.
Sapium mannianum.
Entada spicata.
Salacia gerrardii.
Maesa lanceolata.
Strelitzia sp.
Dalbergia armata.
D. multijuga.
D. obovata.
Acacia ataxacantha.
Clerodendrum glabrum.
Flagellaria guineensis.
Dracaena hookeriana.
Turraea floribunda.
Sideroxylon inerme.
Heteropyxis natalensis.
Spirostachys africana.
Sclerocarya caffra.
Combretum gueinzii.
Tarchonanthus galpinii.
Iboza riparia.

In precipitous situations, *Aloe bainesii*, *Urera tenax*, *Ficus sonderi*, *Cussonia natalensis*, *Euphorbia ingens*, *E. evansii*, *E. triangularis* and *E. tirucalli* also occur.

This forest tends to persist along streams as narrow belts, *Rauvolfia caffra*, *Ficus sycomorus* and *Phoenix reclinata* being the most conspicuous trees. Patches of complete forest are scarce except against the hills towards the upper boundary. In the more or less open bushveld which replaces it, a tall form of *Themeda triandra* is regularly the dominant grass, with abundance of *Panicum maximum* under the trees; and, although thorntrees are the most common (*Acacia arabica* var. *kraussiana*, *A. karroo*, *A. caffra*, *A. gerrardii*, *A. robusta*, *A. woodii*, *A. mossambicensis*, *A. heteracantha*), there are large numbers of species of other trees and shrubs, e.g.:—

Euphorbia ingens.
Sclerocarya caffra.
Albizzia versicolor.
Dichrostachys glomerata.
Gymnosporia senegalensis.
Cussonia spicata.
Spirostachys africana.
Vangueria infausta.
V. cyanescens (Lebombo).
Dombeya rotundifolia.
Ziziphus mucronata.
Sideroxylon inerme.
Schotia latifolia.
Dovyalis caffra.
Phoenix reclinata.
Hyphaene crinita.
Clerodendrum glabrum.
Ficus stuhlmannii.
Aloe spectabilis.
Ficus capensis.
Euclea natalensis.
Fluggea virosa.
Endostemon obtusifolius.
Ricinus communis.
Garcinia livingstonei.
Capparis tomentosa.
Royena galpinii.
Erythrina latissima.
Salacia kraussii.
Portulacaria afra.
Pappea capensis.
Heeria spp.
Peltophorum africanum.
Bauhinia galpinii.
Cussonia natalensis.
Ehretia rigida.

This bushveld is generally thicker at the lower altitudes than at higher altitudes; but there are parts where it has been thinned out to thornveld, mainly *Acacia arabica* var. *kraussiana* and *A. caffra.* The grasses are mainly:—

Themeda triandra.
Tristachya hispida.
Hyparrhenia dissoluta and others.
Cymbopogon excavatus.
C. validus.
Trachypogon capensis.
Chloris gayana.
Setaria perberbis.
Panicum maximum.
Eulalia villosa.
Brachiaria serrata.
Eragrostis chalcantha.
E. capensis.
Andropogon amplectens.
Alloteropsis semialata var. ecklonii.
Bothriochloa glabra.
Panicum deustum.
P. meyerianum.

with great variety and abundance of forbs. It is thus of a sourish mixed nature. *Phoenix reclinata* and *Stangeria eriopus* sometimes occur scattered in the open thornveld.

Form (*b*) *of the Zululand Thornveld* occupies the higher ridges. It is a more open type of veld with patches of short forest and scrub persisting. No well developed forest has been seen, but the relicts which have been examined include such species as:—

Turraea floribunda.
Tricalysia lanceolata.
Commiphora caryaefolia.
C. harveyi.
Rapanea melanophloeos.
Apodytes dimidiata.
Ekebergia meyeri.
Syzygium cordatum.
Trichilia emetica.
Clerodendrum glabrum.
Cassine spp.
Acacia woodii.
Rauvolfia caffra.
Cussonia spicata.
Grewia occidentalis.
Dichrostachys glomerata.
Strelitzia sp.
Randia rudis.
Gymnosporia peduncularis.
Ficus sycomorus.
F. natalensis.
Olea africana.
Gymnosporia senegalensis.
Combretum gueinzii.
Euclea natalensis.
Cadaba natalensis.
Azima tetracantha.
Schotia latifolia.
Acacia davyi.
Premna mooiensis.
Maerua triphylla.
Rhoicissus cuneifolius.
Clausena anisata.
Psychotria capensis.

i.e. sub-tropical and generally of rather a dry type, in a sour grassveld of sub-tropical type, but including as a characteristic species a huge tufted *Eragrostis* sp. in considerable quantity. This grass is prominent on the top of the Lebombo Range, too; here the bushveld and forest of Form (*a*), and the scrub-forest, bush-clump veld and open thornveld of Form (*b*) can all be seen within the space of a few miles. Here the following grasses have been noted:—

Themeda triandra.......	Ab	Andropogon amplectens	F.
Eragrostis chalcantha....	ab.	Eulalia villosa..........	f.
Tristachya hispida......	C.	Rhynchelytrum repens..	f.
Trachypogon capensis...	C.	Eragrostis sp. (huge-tufted)	1f.
Heteropogon contortus..	C.	Rhynchelytrum setifolium	ff.
Elyonurus argenteus.....	c.		
Schizachyrium semiberbe.	C.		

Eragrostis capensis......	c.	Aristida barbicollis......	ff.
Brachiaria serrata.......	c.	Cymbopogon excavatus.	o.
Hyparrhenia buchanani..	1Ab.	Eragrostis chloromelas..	o.
		Bewsia biflora..........	o.

i.e. a dense and strongly sour veld. It has the wealth of forbs usual in the warmer sub-tropical grassveld types. Under excessive grazing pressure it breaks down into *Digitaria swazilandensis* and *Cynodon dactylon.*

This veld type is valuable cattle country, to which the type of semi-intensive farming system being worked out at Rietvlei Research Station could be applied; but much of it is unusable because of nagana.

7. The Eastern Province Thornveld.

This veld type corresponds to the 'Ngongoni veld, but is less sharply differentiated from the coastal belt, especially south-westwards, because in these somewhat drier and more southerly regions, the coast belt is not so markedly luxuriant and evergreen.

Although the climax would have been short forest and scrub-forest, this veld is to-day essentially thornveld, with few species besides *Acacia karroo*, sometimes none at all. It is sometimes so open as to be practically grassveld, e.g. around King William's Town. Forest relicts are rare and tend to occur as narrow belts along streams. North of the Great Kei River the topography is steeply rolling, but south of that river it is flatter. Rainfall ranges from under 20 to 35 inches, mainly 25–30 inches per annum.

Two main variations can be distinguished:—

(*a*) The northern, or typical form;

(*b*) the southern form, south of the Great Fish River, in which elements of the Fynbos are more or less important. In this southern part, the rainfall is rather more evenly distributed through the year. The forests in either case differ little from those of the 'Ngongoni Veld, apart from lacking the more strictly tropical trees.

In *Form* (*a*), the typical form, the grass is dense and of sourish mixed type, with such grasses as:—

Themeda triandra.
Tristachya hispida.
Andropogon amplectens.
Heteropogon contortus.
Elyonurus argenteus.
Eragrostis capensis.
Brachiara serrata.
Sporobolus capensis.
Digitaria eriantha var. stolonifera.
Digitaria littoralis.
D. diagonalis.
Cymbopogon marginatus.
C. excavatus.
Trachypogon capensis.
Helictotrichon hirtulum.
Eragrostis plana.
Eulalia villosa.
Eustachys paspaloides.

with patches of *Hyparrhenia hirta* and a great variety of forbs, e.g.:—

Cassia mimosoides.
Ficinia spp.
Cyperus compactus.
Schistostephium crataegifolium.
Eriosema kraussianum.
E. squarrosum.
Senecio retrorsus.
S. speciosus.
S. bupleuroides and others.
Indigofera hedyantha.
I. hilaris.
I. poliotes.
Aristea cognata.
Lobelia erinus var. bellidifolia.
Helichrysum odoratissimum.
H. miconiaefolium and others.
Scabiosa columbaria.
Linum thunbergii.

Tephrosia macropoda.
Thunbergia capensis.
Monsonia ovata.
Oldenlandia natalensis.
Watsonia meriana.
Acalypha peduncularis.

Fynbos influence is seen in the abundance of *Ficinia* spp., patches of *Bobartia gracilis* on stony outcrops and the occasional presence of *Cliffortia linearifolia*, *Selago corymbosa* and *Elytropappus rhinocerotis*. This influence does not extend beyond the Great Kei, however. Sourness varies a good deal, parts being relatively sweet, where *Themeda*, *Digitaria* and *Hyparrhenia* dominate on doleritic soil.

In *Form* (*b*), the grasses are the same, with the addition of *Pentaschistis angustifolia*, *Danthonia curva*, *Ehrharta calycina*, *Setaria perennis* and patches of *Danthonia disticha*, while the fine wiry sedges (*Schoenoxiphium*, *Ficinia*, *Tetraria*, *Bulbostylis*) are strongly represented, particularly in the sandier parts, where selective grazing will make the veld extremely sour. This form of the veld type occupies more broken country and the soil is generally poorer, on sandstone and quartzite, which together with the round-the-year rainfall, will explain both the frequency of relict patches of short forest and the importance of the Fynbos element. This latter appears in various ways, e.g. as invasions of *Elytropappus rhinocerotis*; as the pioneer on old fallows (*Gnidia myrtifolia*, *Selago corymbosa*, etc.); as a marginal fringe around bush-clumps and at the edge of the valley bushveld (*Passerina sp. Agathosma ovata*, *Aspalathus nivea*); as patches of *Bobartia gracilis* and *Leucospermum muirii*; or generally as single bushes scattered as forbs amongst the grass (*Metalasia muricata*, *Erica glumaeflora*, *Aspalathus laricifolia*, *Struthiola parviflora*, *S. argentea*, *Corymbium africanum*, *Restio triticeus*, *Thamnochortus glaber*, *Anthospermum paniculatum*, *Pteronia teretifolia*, *Gnidia nodiflora*, *Gamolepis brachypoda*, *Agathosma cerefolia*, *Disparago ericoides*, *Muraltia macowani*, *Arctopus* sp., etc.) and is encouraged by selective grazing.

Stages in the Reversed Succession are:—

(1) Short forest (the Climax).
(2) Bush clumps in sourish mixed thornveld.
(3) Sourish mixed to sour thornveld with some Fynbos species.
(4) Invasion by and thickening up of Fynbos species.

In this veld type as a whole, soil erosion is not general, but it does occur, mainly at the edges of the valleys. *Senecio retrorsus* and others of the same group are sometimes abundant.

Included in this veld type is the anomalous veld to the west and south-west of King William's Town, a very open thornveld in which the ground surface is made up of a series of basins and hummocks two to three feet high of ripple form. These undulations appear to be caused by the activities of a large population of giant earthworms in a shallow soil on an impervious layer of concretionary ironstone. The *Themeda*-dominated grassveld, though of slightly drier type, is similar to the typical form, but has a high proportion of *Cynodon dactylon*, *Sporobolus capensis*, *Eragrostis plana* and *Digitaria eriantha* var. *stolonifera*, no doubt as a result of the soil-disturbing habits of the earthworms. These hummocks are of quite different nature and origin from the " heuweltjies " of the western coast belt.

Most of the veld types so far described occupy the ridges between the deep valleys of the rivers. Between these veld types and the valley bushveld, scrub and lowveld of the valleys are numerous interesting and instructive transitions; these however, can be more conveniently dealt with when describing the Valley Bushveld and related types.

II.—INLAND TROPICAL FOREST TYPES.

8. North-eastern Mountain Sourveld.

[See Taljaard, Photos 80, 82, 90, 91, 94; Hutchinson, facing pp. 321 (Barberton, Graskop), 320 (Haenertsburg); Adamson, Photos 5, 6, 7.]

Whereas southwards the tropical forest is confined to the coast belt, in the neighbourhood of Nongoma we find it occurring on the inland mountains as well. Extensive patches of it survive on the mountain range between Nongama and Vryheid (Ceza, Ngome and other forests); northwards it occurs on the Louwsburg heights, the mountains of Swaziland, the mountains south and west of Barberton, there passing on to the Drakensberg and continuing northwards to the Zoutpansberg, with outliers on the higher, wetter parts of the mountains westwards to the Waterberg. The rainfall is high, ranging on the average from 35 to over 75 inches per annum, but it has been declining steadily for about 15 years.

The climax all through will have been high forest, and although miles of this forest survive, especially north of the Crocodile River along the Drakensberg escarpment, most of it has been replaced by sour grassveld, a pure grassveld on the mountain tops, but a scrubby thornveld, reminiscent of that of the coast belt, on the escarpment and slopes.

Few really good samples of this forest have been examined; so far as the records go, the trees of general occurrence (excluding the Zoutpansberg) are:—

Rapanea melanophloeos	3,017	Halleria lucida	61
Xymalos monospora	1,114	Ilex mitis	29
Podocarpus latifolius	744	Pittosporum viridiflorum	27
Syzygium gerrardii	97	Kiggelaria africana	19
Combretum kraussii	90	Trimeria grandifolia	11
Cussonia spicata	84	Brachylaena discolor	7

Trees of less general occurrence include:—

Trichilia emetica	517	Rhus legati	4
Pterocelastrus galpinii	435	Ficus capensis	3
Trichocladus grandiflorus	435	Trema guineensis	3
Curtisia faginea	22	Apodytes dimidiata	3
Bersama tysoniana	20	Cassipourea gerrardii	3
Cussonia umbellifera	17	Seemannaralia gerrardii	3
Fagara davyi	16	Syzygium cordatum	2
Pygeum africanum	16	Olea woodiana	2
Ptaeroxylon obliquum	12	Protorhus longifolia	2
Lachnopylis floribunda	10	Scolopia ecklonii	2
L. schistotricha	10		

Shrubs and climbers of general occurrence are:—

Gymnosporia harveyana	2,668	Burchellia bubalina	91
Peddiea africana	995	Royena cordata	82
Psychotria capensis	978	Scutia myrtina	81
Behnia reticulata	946	Secamone alpini	54
Clausena anisata	877	Maesa lanceolata	45
Cissampelos torulosa	859	Grewia occidentalis	44

Asparagus plumosus	781	Rhamnus prinoides	36
Rhoicissus rhomboideus	694	Buddleja salvifolia	33
Carissa bispinosa	688	Heteromorpha trifoliata	9
Senecio deltoideus	485	Cyathea dregei	0·3
Canthium spinosum	272		

Shrubs and climbers of less general occurrence include:—

Mikania capensis	742	Grumilea kirkii	123
Cassinopsis ilicifolius	545	Berkheya (Stobaea bipinnatifida)	39
Cassine tetragona var. laxa	517	Rhoicissus cuneifolius	38
Rubus sp.	514	Calpurnia sylvatica	37
Tylophora sp.	499	Smilax kraussiana	26
Cnestis natalensis	494	Vaccinium exul	26
Dalbergia obovata	494	Acacia ataxacantha	25
Tricalysia lanceolata	435	Helinus integrifolius	25
Allophylus monophyllus	373	Hypericum leucoptychodes	25
Royena lucida	372	Vernonia podocoma	25
Aloe arborescens	248	Dioscorea dregeana	20
Dioscorea cotinifolia	248	Uvaria caffra	20
Senecio quinquelobus	248	Canthium gueinzii	17
Rhoicissus capensis	247	Dracaena hookeriana	17
Ctenomeria capensis	123	Clerodendrum glabrum	16

and many more.

Generally occurring smaller plants of the forest-floor and margin are:—

Cyperus albostriatus	26,035	Pteris biaurita	671
Galopina circaeoides	25,130	Impatiens duthieae	457
Oplismenus hirtellus	16,000	Asparagus virgatus	166
Acanthaceae (various)	9,136	Argyrolobium tomentosum	131
Pellaea viridis	6,748	Schistostephium rotundifolium	81
Blechnum attenuatum	4,817	Solanum aculeatissimum	13
Peperomia reflexa	3,806	Cyathula cylindrica	8
Moraea iridioides	1,383	Piper capense	3
Plectranthus spp.	1,301	Senecio panduraefolius	3
Polystichum luctuosum	731		

Of less general occurence are:—

Selaginella kraussiana	4,054	Asplenium praemorsum	494
Sanicula europaea	3,178	Centella coriacea	448
Begonia sp.	2,311	Panicum maximum	444
Plectranthus spp.	2,311	Stipa dregeana var. elongata	444
Brachypodium flexum	2,289	Fleurya mitis	373
Stachys grandifolia	1,778	Desmodium scalpe	372
Hyparrhenia cymbaria	1,584	Cyperus sp.	123
Clivia sp.	1,423	Schoenoxiphium sparteum	123
Ehrharta erecta	1,423	Oldenlandia natalensis	111
Melinis macrochaeta	903	Pteridium aquilinum	109
Carex spicato-paniculata	741	Streptocarpus wendlandii	105

and many more, the total number of species in the Relative Abundance Table being 312.

The sourveld, the North-Eastern Mountain Sourveld, which replaces this forest is a strongly sour, *Themeda*-dominated veld. It is not so dense as more southerly types, though the tufts may be larger.

Typical species are:—

Themeda triandra......	330,400
Loudetia simplex.......	154,677
Rendlia nelsonii.......	102,396
Eragrostis chalcantha...	87,200
Monocymbium ceresiiforme	66,588
Paspalum commersonii var.	58,790
Eragrostis plana........	44,211
Trachypogon capensis...	34,906
Tristachya hispida......	17,045
Microchloa caffra.......	15,102
Alloteropsis semialata. var. ecklonii	12,000
Andropogon schirensis..	10,265
Schizachyrium semiberbe	7,347
Hyparrhenia hirta......	4,200

The following are of lesser importance:—

Sporobolus capensis.....	2,392
Setaria nigrirostris.......	2,353
Digitaria monodactyla...	1,176
Ficinia spp.............	1,176
Andropogon amplectens.	816
Helichrysum oreophilum.	816
Panicum ecklonii........	410
P. natalense............	410
Protea sp...............	410
Andropogon filifolius....	204
Brachiaria serrata.......	204
Eulalia villosa..........	204
Cymbopogon validus....	186
Elyonurus argenteus....	118
Festuca costata.........	5
Ctenium concinnum.....	3
Trichopteryx dregeana...	1
Digitaria tricholaenoides	1
Erica drakensbergensis..	1
Protea rouppelliae......	1

Quite often one sees rows of *Cyathea dregei* along streams in the grassveld, while *Strelitzia caudata* is sometimes plentiful in the scrubbier forest of precipitous slopes.

The scrubby thornveld of mountain slopes includes such species as *Athanasia acerosa*, *Lippia asperifolia*, *Stoebe vulgaris*, *Cliffortia linearifolia*, *Hypericum leucoptychodes*, *Royena galpinii*, *Sutera grandiflora*, *Buddleja salvifolia* and *Leucosidea* along streams, *Maesa lanceolata*, *Solanum aculeastrum*, *Erica woodii*, *Dissotis princeps* and *Caesalpinia sepiaria*, sometimes forming dense thickets where, apparently, the breaking down of the forest into grassveld or thornveld has never been completed. Much of this veld type has been replaced by plantations of pines, blue-gums and wattles.

9. LOWVELD SOUR BUSHVELD.

(See Taljaard, Photos 97, 99; Hutchinson, pp. 323, 324, 370, 371, 372.)

This veld type covers the lower eastern slopes and foothills of the mountains of Swaziland and of the Drakensberg and Zoutpansberg northwards. It is transitional between the Lowveld and the North-Eastern Mountain Sourveld and is related to the Waterberg Sourveld. The climax is probably tropical forest, the rainfall ranging from 20 inches per annum at the lower margin where it merges into the Lowveld, to over 40 inches at its upper margin, where it merges into the north-eastern mountain sourveld, its limits being somewhat indefinable. To-day it is either an open parkland, tall, well-formed trees well spaced in tall grassveld, or else bushveld dotted with big trees.

Typical trees and shrubs in both forms are:—

Trichilia emetica.
Parinari curatellifolium.
Sclerocarya caffra.
Acacia woodii.
Pterocarpus angolensis.
P. rotundifolius.
Faurea saligna.
Faurea speciosa (at higher levels).
Acacia caffra.
A. davyi.
Ficus petersii.
F. ingens.
F. natalensis.
F. sycomorus.
Peltophorum africanum.
Diospyros mespiliformis.
Euphorbia ingens.
Lonchocarpus capassa.
Bauhinia thonningii.
Combretum zeyheri.
C. suluense.
Schotia brachypetala.
Terminalia sericea (on sand).
Rauvolfia caffra (stream banks).
Syzygium cordatum (stream banks).
Chrysophyllum magalismontanum var. depauperata (rocky places).
Dombeya rotundifolia.
Lannea discolor.
Pavetta edentula.
Dichrostachys glomerata.
Annona sp.
Antidesma venosum.
Duranta plumieri.
Anthocleista zambesiaca.
Phoenix reclinata.
Gymnosporia senegalensis.
Aloe spectabilis.

Belts of forest occur along the rivers, dense and tangled, with such lianas and scramblers as *Dalbergia obovata*, *D. armata*, *Bauhinia galpinii*, *Acacia ataxacantha*, *Smilax kraussiana* and *Toddalia asiatica*.

The grassveld constituent is tall, strongly tufted and relatively sparse, with a good deal of scrubbiness. Common species are:—

Hyparrhenia dissoluta.
H. buchanani.
H. sp. cf. H. glauca.
H. cymbaria.
Schizachyrium semiberbe.
Cymbopogon excavatus.
C. validus.
Andropogon schinzii.
A. schirensis.
Eragrostis sp. cf. E. robusta.
E. capensis.
E. chalcantha.
Loudetia simplex forma.
Rhynchelytrum setifolium.
Brachiaria brizantha.
Heteropogon contortus.
Themeda triandra.
Setaria sphacelata.
Pogonarthria squarrosa.
Trachypogon capensis.
Bothriochloa glabra.
Bewsia biflora.
Andropogon amplectens.
Eulalia villosa.
Lippia asperifolia.
Royena galpinii.
Flemingia grahamiana.
Psidium guajava.
Elephantorrhiza elephantina.
Lannea edulis.
Setaria chevalieri.
Vernonia podocoma.
Sutera grandiflora.
Athrixia phylicoides.
Helichrysum kraussii.
Artemisia afra.
Hypoxis rigidula.
Triraphis andropogonoides.

It is thus of sourish mixed nature, of poor quality for grazing and difficult to manage. *Themeda* and the other sward-forming grasses, while present, are no longer dominant as they are in the veld types hitherto described.

Spectacular soil erosion occurs in this veld, but is localized, taking the form of single dongas of great size and often of remarkable colouring—orange, rose-pink and pure white. It is a feature of granite country in the wetter parts and is also seen at Lions Head at Cape Town and Matlapynsberg in Rustenburg district. Some of these dongas are old, as evidenced by the size of the trees growing in them; and it is interesting to note how, at higher altitudes, e.g. in the Piet Retief Sourveld, or in drier country, e.g. at Magut, the forest species will colonize them. Such isolated dongas are capable of forming without any general denudation of the countryside, in cases where a natural dam across a river, in the shape usually of a dolerite dyke, becomes breached. The river-bed upstream is then likely to become scoured out, leaving high banks from which dongas have the opportunity of eating back along the tributaries. This could have happened long before the Bantu appeared on the scene, so that such dongas could provide natural migration routes for the forest into higher-lying or drier country.

III.—TROPICAL BUSH AND SAVANNAH TYPES (BUSHVELD).

10. Lowveld.

[See Taljaard, Photos 83, 84; Marloth II, 2, Fig. 113; III, 2, Fig. 72; Hutchinson, facing pp. 321 (Komatipoort), 481 (Komatipoort), p. 367; King, Fig. 69.[

This veld type occupies the plains, at altitudes between 500 and 2,000 feet above the sea, between the eastern foot of the Drakensberg and other mountains southwards through Swaziland and Zululand, and the western foot of the Lebombo range, and replaces the valley bushveld in the deep valleys north of the Tugela. It also occurs along the eastern foot of the Lebombo Range. There is no clear-cut boundary between this veld and the Lowveld Sour Bushveld or the Zululand Thornveld, particularly on the lighter soils. Most of the soils, however, are heavy, derived from volcanic rocks, and on them the characteristic open *Acacia nigrescens–Sclerocarya–Themeda* savannah of the Lowveld is developed. Large numbers of other species are often present, mainly in valleys, or on rocky hills and on the sandier soils; here the bush is denser.

Rainfall ranges from 20 to 30 inches per annum, falling in summer, and the climate is hot.

Typical trees and shrubs are:—

Acacia nigrescens.
Sclerocarya caffra.
Ziziphus mucronata.
Dichrostachys glomerata.
Gymnosporia senegalensis.
Schotia brachypetala.
Euphorbia ingens.
E. tirucalli.
E. grandicornis.
E. cooperi.
Peltophorum africanum.
Dombeya rotundifolia.
Lonchocarpus capassa.
Acacia davyi.
A. arabica var. kraussiana.
A. senegal.
A. gerrardii.
A. mossambicensis.
A. burkei.
Heeria paniculosa.
Ficus stuhlmannii.
Kigelia pinnata.
Ormocarpum trichocarpum.
Bolusanthus speciosus.
Combretum apiculatum.
C. transvaalense.
Grewia hexamita.
G. populifolia.
Cissus quadrangularis.
Albizzia versicolor.
Cladostemon kirkii (Lebombo).
Phyllanthus reticulatus (Lebombo).
Vitex harveyana (Lebombo).
Olax dissitiflora (Lebombo).
Gossypium herbaceum var. africanum.
Bauhinia galpinii.

A. heteracantha.
Syzygium guineense.
Spirostachys africana.
Euclea lanceolata.
Mimusops concolor.
Pseudocassine transvaalensis.
Capparis tomentosa.
Olea africana.
Heeria insignis.
Cissus sp. (=A. 13094).
Sterculia murex.
and many more.

Commiphora betschuanica.
Strychnos innocua.
Balanites maughami.
Cussonia natalensis.
Kirkia wilmsii.
Terminalia phanerophlebia.
Royena glandulosa.
Garcinia livingstonei.
Cadaba natalensis.
Pterolobium exosum.

Towards the upper margin, bush clumps occur, associated with termitaria, in which may be found the trees of the Lowveld Sour Bushveld. Along the rivers is generally a narrow belt of near-forest in which *Acacia robusta*, *A. mossambicensis*, *A. xanthophloea* (north of Hluhluwe R.), *A. albida*, *Euphorbia tirucalli*, *Rauvolfia caffra*, *Phoenix reclinata*, *Hyphaene crinita* and *Ficus sycomorus* are conspicuous.

The dominant grass is a tall form of *Themeda triandra*, particularly on the heavy soils; on these soils it is associated with—

Panicum maximum.
P. deustum.
Setaria woodii.
Bothriochloa insculpta.
Eragrostis superba.
E. sp. cf. E. nebulosa.
Aristida bipartita.

Urochloa pullulans.
Digitaria sp.
Cymbopogon excavatus.
Diplachne eleusine.
Brachiaria sp. cf. B. stolonifera.
Sporobolus fimbriatus.
Setaria chevalieri (along rivers).

i.e. a good sweetveld. The creeping grasses and *Aristida bipartita* tend to become common with overgrazing.

On sandy soils, *Themeda* is less dominant and is associated with—

Eragrostis superba.
E. sp. cf. E. atherstonei.
Aristida diffusa var. burkei.
Heteropogon contortus.
Aristida sciurus.
Tristachya hispida.
Elyonurus argenteus.
Andropogon amplectens.
Tricholaena monachne.
Eustachys paspaloides.
Sporobolus fimbriatus.
Rhynchelytrum repens.
Eragrostis curvula.

Digitaria tricholaenoides (sometimes).
Trichoneura grandiglumis.
Panicum coloratum.
Cymbopogon excavatus.
Eragrostis gummiflua.
E. lappula.
E. sclerantha.
Pogonarthria squarrosa.
Brachiaria nigropedata.
B. serrata.
Cymbopogon plurinodis.
Hyparrhenia hirta.

i.e. a mixed veld, rather on the sour side; it is poor and relatively sparse, and tends to tramp out to *Digitaria eriantha* var. *stolonifera*, *Aristida barbicollis*, *Eragrostis* sp. cf. *E. atherstonei*, *Perotis indica*, *Pogonarthria* and such wiry grasses.

Forbs and bushy plants are plentiful, e.g.:—

Lippia asperifolia.
Helichrysum sp. cf. H. rosum.
Talinum caffrum.
Tephrosia semiglabra.

Stylosanthes mucronata.
Rhynchosia densiflora.
R. cyanospermum.
Hoslundia opposita var.

Crotalaria australis.
Orthosiphon serratus.
Ocimum americanum.
Kalanchoe rotundifolia.
Pollichia campestris.
Sericocoma avolans.
Oxygonum zeyheri.
Ipomoea crassipes.
Aster luteus.
Scilla spp.
Zornia tetraphylla.
Waltheria americana var. indica.
Aloe spp.
Adenia glauca.
Ipomoea albivenia.
Dyschoriste rogersii.
Mucuna irritans.
Bauhinia kirkii.
Cocculus hirsutus.
Schizobasis intricata (rocky places)

and many more.

11. ARID LOWVELD.

(See Adamson, Photo 9.)

This, too, is typically an *Acacia nigrescens–Sclerocarya* savannah, but with *Digitaria* sp. taking over the role of dominant grass from *Themeda. Acacia* spp. are more important and so are *Combretum* spp. especially *C. apiculatum*; and in parts northwards, *Copaifera mopane*, providing an easy transition to Mopani veld. Other typical trees and shrubs are:—

Spirostachys africana.
Ziziphus mucronata.
Combretum imberbe.
Acacia exuvialis.
A. dulcis.
Euclea divinorum.
Grewia flavescens and others.
Sterculia rogersii.
Terminalia prunioides.
Cassia abbreviata var. granitica.
Diospyros mespiliformis.
Ficus soldanella.
Steganotaenia araliacea.
Mundulea sericea.
Pterocarpus rotundifolius.
Ximenia americana var. microphylla.
Maerua mashonica.
Dalbergia melanoxylon.

with *Adansonia digitata* appearing north of the Olifants River.

The grasses include—

Andropogon schinzii.
Cymbopogon plurinodis.
Heteropogon contortus.
Themeda triandra.
Schmidtia bulbosa.
Enneapogon scoparius.
Eragrostis superba.
E. sp. cf. E. atherstonei.
Digitaria eriantha var. stolonifera.
Eustachys paspaloides.

This mixed veld breaks down to *Eragrostis* sp. cf. *E. atherstonei*, *Schmidtia bulbosa* and *Aristida barbicollis* under grazing pressure.

This veld type requires further study; thus, it is probable that the western fringe of it should rather have been shown on the map as Lowveld. The southern outliers on the western side of the southern end of the Lebombo Range in the dry valleys of the Pongola and Umkuzi Rivers, however, have been better studied. The veld here is typical *Acacia nigrescens–Sclerocarya* Savannah, varying sometimes to *Acacia nigrescens–A. heteracantha*, or *Acacia nigrescens–Heeria* Savannah, with *Digitaria* sp. the dominant grass, together with much *Themeda.*

A feature of this veld is the dense, low thickets which occur along watercourses and along the foot of the Lebombo Range, both on the west and the eastern sides; they are reminiscent of the Addo Bush, though most of the species are different, and are related to the coastal jungle of Northern

Zululand in the same way that the Addo Bush is related to the Alexandria Forest. On the banks of the main rivers, however, the usual tall near-forest with *Acacia xanthophloea*, persists.

The principal species in the dense bush are:—

Acacia gillettiae (dominant).
A. nigrescens.
Euclea undulata.
Capparis citrifolia.
C. tomentosa.
Ehretia rigida.
Acacia senegal (sometimes).
Sarcostemma viminale.
Rhamnus zeyheri.
Dinocanthium hystrix.
Gymnosporia buxifolia.
Spirostachys africana.
Strophanthus gerrardii.
Euclea divinorum.
E. daphnoides.
Pappea capensis.
Mimusops concolor.
Atalaya alata.
Tecomaria capensis.
Olea africana.
Premna mooiensis.
Euphorbia grandicornis.
Ptaeroxylon obliquum.
Salvadora australis.
Cordia caffra.
Chaetacme aristata.
Schotia brachypetala.
Schotia transvaalensis.
Cissus quadrangularis.
Gymnosporia fasciculata.
Teclea natalensis.
Cladostemon kirkii (foot of Lebombo).
Azima tetracantha (rare).
Euphorbia evansii (rare).
E. ingens (rare).
Cassine schlechteri.

with, amongst the smaller plants

Panicum deustum.
Barleria elegans.
Justica flava.
Cissus sp. = A. 13094.
Sanseviera sp. cf. S. zeylanica.
S. thyrsiflora.
Talinum caffrum.
Asparagus falcatus.
Bothriochloa insculpta.
Diplachne eleusine.
Dicliptera quintasii.
Polygala ukambica.
Hibiscus calyphyllus.
Aloe sp. (Saponariae).

and a lot more.

Most of the remaining bushveld types, as has already been explained, have not been studied during this survey, so that little more will be said about them than was said in Irvine's Quinquennial Report on Towoomba Research Station. As this report was not published, however, this information will be valuable.

12. Springbok Flats Turf Thornveld.

This veld type occupies the plains between the Waterberg and the Elands–Olifants valley, with a northward extension past Potgietersrust. It is extremely flat country, hot, with a summer rainfall of 17–30 inches per annum. It is naturally an open thornveld, but tends to thicken up when the grass cover is reduced by grazing mismanagement. Irvine has drawn the writer's attention to the fact that there is also a tendency for bush to invade areas where the grass cover is undamaged; it is suggested that this can only be the result of a climatic change, difficult to establish in these parts owing to the shortness of the records, but no doubt correlated with the undeniable change which has occurred in the older settled parts of the Union.

Two main variations can be distinguished: (*a*) Red Turfveld. (*b*) Black Turfveld.

(*a*) *Red Turfveld.*—(See Taljaard, Photo 75; Hutchinson, facing p. 480.) This is a fairly dense thornveld, the principal species being *Acacia heteracantha, A. arabica* var. *kraussiana, Dichrostachys glomerata, Ziziphus mucronata, Acacia gerrardii* and *Grewia flava.* The grass is of mixed type, dominated by *Themeda,* often with much *Cymbopogon plurinodis.* The principal species are:—

Themeda triandra.
Cymbopogon plurinodis.
Bothriochloa insculpta.
Digitaria argyrograpta.
Eragrostis superba.
Brachiaria nigropedata.
Heteropogon contortus.
Elyonurus argenteus.
Panicum coloratum.
Aristida canescens.
Hyparrhenia hirta.
Eragrostis sp. cf. E. atherstonei.
Pogonarthria squarrosa.

Selective grazing encourages *Cymbopogon,* while over-grazing will break it down to *Eragrostis* sp. cf. *E. atherstonei, Bothriochloa* and *Hyparrhenia,* with abundance of *Aristida barbicollis.* This veld occupies the relatively higher lying parts.

(*b*) *Black Turfveld.*—This is a more open thornveld, in low-lying places practically grassveld. The prinicpal trees are *Acacia karroo, A. arabica* var. *kraussiana* and *Ziziphus mucronata,* scattered in a dense, tall, coarsely-tufted grassveld.

The principal species are:—

Ischaemum glaucostachyum.
Sehima galpinii.
Setaria woodii.
Themeda triandra.
Elyonurus argenteus.
Digitaria sp.
Eragrostis chloromelas.
Panicum coloratum.
Bothriochloa insculpta.
Fingerhuthia africana.
Enneapogon scoparius.

Sehima is apparently the climax species, still persisting as dominant in protected low-lying places. Other species often of importance are *Sorghum versicolor, Aristida bipartita* and the annuals, *Sesbania mossambicensis* and *Brachiaria eruciformis.* These are associated with ancient cultivation, but are very persistent. *Aristida bipartita* is dominant over large areas.

In both these forms overgrazing causes the bush to thicken up into almost impenetrable thickets of *Acacia arabica* var. *kraussiana, Dichrostachys glomerata, Gymnosporia buxifolia* and *Acacia karroo,* while in low lying places the shorter *Acacia tenuispina* (especially on black turf), A. karroo (shrubby form), *A. gillettiae, Grewia flava, Asparagus laricinus* and *A. stipulaceus* also become common, shading out the grasses and greatly reducing the grazing value of the veld.

An intermediate form between the Red and the Black Turfveld is the Chocolate Turfveld, a fairly dense *Acacia arabica* var. *kraussiana* thornveld with *Acacia karroo* and *A. heteracantha,* in a *Themeda–Setaria woodii* grassveld with *Bothriochloa inculpta, Elyonurus argenteus* and sometimes *Sehima.*

Much cultivation is carried on on the Springbok Flats, but (in spite of the apparently almost inexhaustible fertility of the soil), the erratic nature of the rainfall, the heat, and the relatively poor quality of the grazing in winter make it difficult country for farming.

13. Other Turf Thornveld.

Under this heading falls a group of closely related variations of turf thornveld, some of them occurring in such a way as to be individually unmappable on a small scale.

(*a*) Along the edge of the Elands–Olifants valley, the turfveld of the Springbok Flats merges into the short scrub of the dry valley via a scrubby, rocky belt of short bushveld on a light, grey, turfy soil with a layer of calcareous tufa, often outcropping. Wherever such grey turf on limestone appears in the drier parts of the bushveld and lowveld, a generally similar type of veld is found, rather resembling the drier parts of the Vryburg Shrub Bushveld or the arid kalkveld of South West Africa. There is no extensive area of it, and as it occurs widely scattered as small patches and strips, it shows wide variations. Typical species are:—

Commiphora pyracanthoides.
Boscia rehmanniana.
Grewia flava.
G. kwebensis.
Euclea undulata.
Acacia detinens.
Rhigozum obovatum.
R. brevispinosum.
Tarchonanthus camphoratus.
Rhus spp.
Gymnosporia spp.
Olea africana.
Acacia heteracantha.
A. karroo.
A. gerrardii.
A. stuhlmannii.
Dichrostachys glomerata.
Boscia albitrunca.

while the grassy constitutent is mainly sweet.

Cenchrus ciliaris.
Heteropogon contortus.
Digitaria eriantha var. stolonifera.
Panicum maximum.
Enneapogon scoparius.
Eragrostis sp.
Panicum coloratum.
Schmidtia bulbosa.
Brachiaria nigropedata.
Cymbopogon plurinodis.
Elyonurus argenteus.
Themeda triandra.

but is usually broken down to *Aristida barbicollis*, *A. congesta* and bushy plants, e.g. *Stachys* sp., *Evolvulus alsinoides*, *Melhania* sp. and, particularly, Acanthaceae of the genera *Justicia*, *Blepharis*, *Dyschoriste* and *Petalidium*.

(*b*) The large areas of " Other Turf Thornveld " shown on the veld type map are mainly what Irvine calls *Acacia karroo–Cymbopogon* veld, or Norite black turfveld, with a variation to red turfveld as in the case of the Springbok Flats turfveld, and similarly tending to be dominated by *Cymbopogon plurinodis*. It is typically an open savannah of short *Acacia karroo* with more or less *Acacia robusta* (sometimes dominant), *A. heteracantha* and stunted *Grewia flava* and *Rhus gueinzii*, while *Acacia arabica* var. *kraussiana*, so important on the Springbok Flats, is usually scarce. The important grasses include:—

Setaria sp.
Ischaemum glaucostachyum.
Cymbopogon plurinodis.
Fingerhuthia africana.
Urelytrum sp.
Eragrostis chloromelas.
Panicum coloratum.
Aristida bipartita (sometimes).
Elyonurus argenteus.
Digitaria sp.

Where the Norite forms hills, as it does in the southern strip of turfveld along the northern foot of the Magaliesberg, the vegetation is a dense, short bushveld, with such species as:—

Combretum holosericeum.
Acacia caffra.
Clerodendrum glabrum.
Vangueria infausta.
Euclea lanceolata.
Kirkia wilmsii.
Dombeya rotundifolia.
Sclerocarya caffra.
Pappea capensis.
Grewia flava.
Acalypha glabrata.
Urera tenax.
Ziziphus mucronata.
Ficus ingens.
Ficus petersii.
Celtis kraussiana.
Rhus gueinzii.
Croton gratissimus.
Cussonia paniculata.
Combretum transvaalense.
Rhoicissus cuneifolius.
Pouzolzia hypoleuca.
Royena lucida.
Helinus integrifolius.
Grewia occidentalis.
Lannea discolor.
Brachylaena rotundata.

i.e. decidedly mixed, including species even of forest affinity, while the grasses, etc. (in a rather tramped-out sample) include:—

Setaria lindenbergiana.
Heteropogon contortus.
Sporobolus festivus.
Bothriochloa insculpta.
Digitaria sp.
Themeda triandra.
Dichanthium nodosum.
Lepturella capensis.
Tripogon minimus.
Sporobolus stapfianus.
Cenchrus ciliaris.
Glycine javanica.

The geological structure of the Rustenburg and Marico districts along the western rim of the bushveld lopolith, is so complex, with the norite and quartzites outcropping in alternating belts, that mixed and layered soil-types are of common occurrence, with correspondingly mixed vegetation, e.g. *Acacia caffra* on what is superficially black turf, while around Nietverdiend in Marico district, *Acacia giraffae* forms a distinct veld type, (*c*), on light turfy soil, although this tree is generally associated with deep sand over limestone.

(*d*) Another widely occurring form of grey turf veld, especially in the mixed bushveld to the west and north of the Waterberg is *Knoppiesdoring Veld.* It occurs only as small patches and narrow strips along dykes of basic volcanic rock, sometimes scarcely more than a single row of tall Knoppiesdoring trees (*Acacia nigrescens*) in a strip of sweet *Grewia flava* veld a few yards wide. *Acacia nigrescens* here grows much taller and straighter than it does in the Lowveld. The grass is mainly *Cenchrus ciliaris*, with *Bothriochloa insculpta*, *Digitaria eriantha* var. *stolonifera*, *Enneapogon scoparius* and *Setaria* sp. Here it has been noticed that a surface layer of quartz gravel can cause the under-story of *Grewia flava* to be replaced by *Acacia caffra.*

When the bushveld region is included in the detailed survey, some of these turf thornveld variations will have to be separated as distinct veld types.

14. Arid Sweet Bushveld.

[See Reynolds, Pl. 35; Hutchinson, p. 394, facing p. 481 (Limpopo Valley).]

As delimited on the veld type map, this too is a somewhat heterogeneous type. Thus Irvine recognizes seven sweet veld types, viz:—

(*a*) *Dwarf Terminalia sericea–Rhigozum* veld.
(*b*) *Grewia flava* (Maretwa) veld, including
(*c*) *Dwarf Combretum apiculatum* veld; and

(*d*) *Commiphora pyracanthoides* veld;
(*e*) *Adansonia*—Mixed thorn veld;
(*f*) *Panicum maximum–Acacia karroo* veld;
(*g*) *Dichrostachys–Acacia* veld,

which, until the data have been collected to describe them fully as distinct veld types, we will describe, mainly in Irvine's words, as variations of the broad type, Arid Sweet Bushveld.

(*a*) *Dwarf Terminalia sericea–Rhigozum* sp. *Veld.*

This veld type covers some 1,170 square miles in the valley of the Limpopo between the Matlabas and Mogol Rivers, extending some distance east of the Mogol and lying at an elevation of 2,700–3,100 feet. A further portion of the above area of veld occurs in the Palala valley to the south of Villa Nora. The soil is a deep, fine grey-brown sand overlying granite, quartzite, sandstone and shale. The rainfall varies from 14–20 inches.

" This veld type is a short, scrubby formation of *Terminalia sericea* and *Rhigozum* sp., together with stunted *Grewia flava* and *Acacia heteracantha*. The grass, typical of deep, loose sand is of a coarse, harsh nature—*Eragrostis pallens*, *Schmidtia bulbosa* var., *Eragrostis atherstonei*, *Loudetia simplex*, *Aristida graciliflora* and *A*. sp. There is evidence that formerly sweet grasses such as *Digitaria* and *Panicum* spp. were more abundant".

(*b*), (*c*) (*d*).—" These three types, together covering about 3,000 square miles, extend along the Limpopo valley, in two blocks. The upper or more western block lies between the Crocodile and Matlabas Rivers, and is separated from the lower block by the sandy Dwarf *Terminalia–Rhigozum* veld. This latter block lies between the Mogol and Magalakwin Rivers in the Limpopo valley, but extends southwards across the latter river as far as the Blaauwberg and Zoutpansberg. It is bounded on the north-east by the Mopani veld, along an irregular south-easterly line from near the mouth of the Magalakwin River to the neighbourhood of Waterpoort, with extensions along the valleys of the Brak and Sand Rivers nearly to their junction. The altitude ranges from 2,300–3,100 feet and the rainfall is 13–18 inches. The underlying rock throughout is granite and gneiss, and the typical soil is shallow, gritty and light red in colour, over a limestone layer".

"The entire area indicated above carries *Grewia flava* veld, except in shallow depressions where the limestone layer is at, or near the surface, where Dwarf *Commiphora* veld occurs. Dwarf *Combretum apiculatum* occurs to the west of the Palala where the soil is a shallow, fine, yellow-brown sandy loam."

(*b*) *Grewia flava Veld.*

" This veld type is a fairly dense growth of *Grewia flava* (Maretwa) with a good deal of *Acacia dulcis* (Geelhaak), *A. detinens* and *Dichrostachys glomerata* in varying proportions, some *Commiphora pyracanthoides* and scattered taller trees of *Boscia albitrunca* (Matlopi) and *Acacia heteracantha* (Haak en steek). *Boscia* is the most conspicuous tree, here growing with a tall straight trunk. The grass is naturally decidedly sweet, but has in many parts given place to *Aristida* spp. (Steekgras). *Schmidtia bulbosa*, *Eragrostis* sp. and *Panicum maximum* are the major species with much *Digitaria eriantha* var. *stolonifera* and *Panicum coloratum* and rather less

Enneapogon scoparius, *Brachiaria nigropedata* and *Heteropogon contortus*." This description can be amplified somewhat: typical trees and shrubs are:—

Grewia flava.
Acacia dulcis
A. detinens. } thickets.
A. gillettiae.
A. heteracantha.
Boscia albitrunca.
Acacia karroo.
A. giraffae (southwards).
Cadaba juncea.
Ziziphus mucronata.
Dichrostachys glomerata.
Commiphora pyracanthoides.
Gymnosporia tenuispina.
Peltophorum africanum.
Terminalia sericea.
Grewia spp.
Rhigozum sp. cf. R. obovatum.
Euclea undulata.

while the grasses, etc., include:—

Schmidtia bulbosa.
Eragrostis sp. cf. E. atherstonei.
Digitaria eriantha var. stolonifera.
Heteropogon contortus.
Panicum coloratum.
Aristida barbicollis.
Aristida congesta.
Enneapogon scoparius.
Panicum maximum (ab T).
Dipcadi glaucum.
Cucumis naudinianus.
Brachiaria nigropedata.
Urochloa pullulans.
Eragrostis superba.
Anthephora pubescens.
Aristida uniplumis.
Indigofera daleoides.
Chrysopogon montanus var. tremulus (1C).
Cymbopogon plurinodis.

"In the section to the north of the Blaauwberg and Zoutpansberg, where the rainfall is lower and the soil shallower, this veld is more scrubby and there are some floristic differences, xerophytic shrubs like *Commiphora* spp., *Terminalia prunioides* and *Sesamothamnus lugardii* becoming common." To which may be added *Boscia rehmanniana*, *Psiadia arabica*, *Leucosphaera bainesii*, *Sterculia rogersii*, *Acacia nigrescens* (stunted) and *Catophractes alexandri*.

(*d*) *Dwarf Commiphora Veld* (*Kurkbossie*).

This veld type is a rather mixed scrubby type dominated by a dwarf form of *Commiphora pyracanthoides*. Stunted *Acacia heteracantha*, *Combretum apiculatum*, *Grewia flava* and *Terminalia sericea* are plentiful. The grass, on this shallow, calcium rich soil, is sweet and short. The most abundant grasses are *Urochloa* sp. and *Sporobolus nitens*, with much *Panicum coloratum* and some *Anthephora pubescens*, *Cenchrus ciliaris* and *Enneapogon scoparius*."

(*e*) *Adansonia–Mixed Thornveld.*

„Covers 3,070 square miles immediately to the south of the *Grewia flava* veld just described. It occurs in two blocks, one in the shape of a horseshoe, the horns occupying the middle Palala and Magalakwin valleys—linked by a narrow belt towards the Limpopo Valley. The other, or eastern block, occupies the relatively dry, low-lying area between the Blaauwberg and Zoutpansberg on the north and the Magabeneberg, the northern slopes of the Pietersburg Plateau and the Drakensberg on the west, south and east respectively. The altitude ranges from 2,500–3,400 feet, with a rainfall of 15–20 inches. The underlying rock is again mostly granite, with some Waterberg rocks in the Magalakwin valley, but the soil, a red sandy loam, is deeper and better."

The bush comprises the same species as the *Grewia flava* veld, but is bigger and there is less *Grewia flava*. It also includes *Sterculia rogersii*, *Strychnos* spp., *Acacia* spp. and *Adansonia digitata*, at least in the section to the north-west of the Zoutpansberg; *Adansonia* does not occur in the eastern block. *Hyphaene* sp. occurs along rivers in the Limpopo valley. The grass sward is very similar to that of *Grewia flava* veld, with the addition of more *Anthephora pubescens*, *Eragrostis superba* and *Themeda triandra*, due to the heavier soil."

(*f*) *Panicum Maximum–Acacia Karroo Veld.*

This is the veld of the silty banks of the main rivers, a narrow belt to be measured in hundreds of yards even at its widest. It may also occur in depressions in the neighbourhood of basic intrusions, where there is deep, rich soil and permanent, underground water. It traverses all the sweet and mixed bushveld, and in the sparsely and recently settled bushveld it can still be seen in its full development of tall straight *Acacia karroo* trees standing deep in a luxuriant growth of *Panicum maximum*. It is not confined to the bushveld region, however; indeed it is one of the most widely distributed plant communities. Traces of it are to be seen all along the east and south coasts and through all but the coldest and driest parts of the Karoo region, but as a general rule the *Panicum* has been replaced by dongas. In parts, *Acacia karroo* and *Panicum maximum* are the only plants of importance, e.g. along parts of the Matlabas River, but usually there are a few other trees and grasses as well, e.g. *Combretum erythrophyllum* and its allies, *Ziziphus mucronata*, *Royena pallens*, *Rhus lancea* and other *Rhus* spp., *Panicum deustum*, *Bothriochloa insculpta*, *Chloris gayana* and *Setaria woodii*. In the Karroo region, *Panicum stapfianum*, *Setaria neglecta*, *Digitaria* sp. and *Sporobolus fimbriatus* are rather the associates of the two *Panicum* spp., sometimes largely replacing them, e.g. at Doornhoek, near Cradock to the west. Along the Vaal River and its tributaries, *Dichanthium annulatum* and *Eragrostis margaritacea* become important members of the community, as well, sometimes as *Echinochloa holubii*, *Panicum laevifolium* and *Diplachne fusca*. The association of the last three (which are vlei-grasses) with *Acacia karroo* is, however, probably artificial. It could come about when conversion of the river into a donga had drained the former riverine vlei sufficiently to permit *Acacia karroo* to invade.

(*g*) *Dichrostachys–Acacia Veld.*

This community occurs on hard, brak, sandy slopes on the sides of river valleys in the drier parts of the bushveld above the silt level. It, too generally occurs as narrow belts, rarely as much as half a mile wide, but there is one extensive area of it along the Marico River below Derdepoort; further, it is not confined to the main river valleys, but occurs along minor watercourses and in brak depressions, e.g. Warmbaths stands in a patch of it, which includes the north-western corner of Towoomba Research Station; this, however, is a somewhat wetter variation of it.

In the drier parts it is a dense, short growth of *Acacia detinens*, *A. dulcis*, *Dichrostachys glomerata* and sometimes *Acacia gillettiae*, often forming impenetrable thickets, with a good deal of *Boscia albitrunca* and *B. rehmanniana*. In the less dry parts, e.g. at Warmbaths or 20 miles north of Pretoria on the Warmbaths road, the dominants are *Dichrostachys*, stunted *Acacia heteracantha*, *Euclea undulata*, *Spirostachys africana*, *Carissa bispinosa*, *Sarcostemma viminale*, *Senecio pleistocephalus* and *Gymnosporia buxifolia*, sometimes also *Acacia arabica* var. *kraussiana*. The principal grasses, etc., are:—

Sporobolus nitens.
Urochloa sp. (creeping).
Panicum coloratum.
Eragrostis obtusa.
Cyperus teneriffae.
C. semitrifidus.
Enneapogon scoparius.
Fingerhuthia africana.
Sporobolus festivus.
Pterodiscus speciosus.
Mariscus sp. (A. 12460).
Kyllinga alba.

while there is a dense, semi-succulent undergrowth in the thickets, including:—

Kalanchoe rotundifolia.
K. sp.
Crassula sessilicymula.
C. transvaalensis.
Senecio sp. cf. S. fulgens.
Cyanotis nodiflora.
Justicia flava.
Ruellia sp.
Aster muricatus.
Commelina benghalensis.
Pollichia campestris.
Coleus pentheri.
Aloe transvaalensis.
Vellozia rosea.
Asparagus stipulaceus.
Sansevieria zeylanica.
? Delosperma sp.

Soil erosion is a conspicuous feature of this community, which itself is probably largely the result of concentration of grazing caused both by its sweetness and its position in the neighbourhood of water, the climax probably having been something approaching *Grewia flava* veld. This veld is the north-western equivalent of the dense scrub of Zululand (see p 50.) and the Valley Bushveld and its allies. Less scrubby forms of it occur, too, but these will be described with the Mixed Bushveld as Thornveld and *Combretum imberbe* veld.

15. MOPANI VELD.

[See Hutchinson, p. 326, facing pp. 416, 417 (Messina), 481 (Messina).]

There are two blocks of this distinct veld type: (1) in the wide, gently undulating valley of the Limpopo below the eastern part of the Zoutpansberg; altitude ranges from 1,300–2,500 feet and the rainfall from 10–15 inches per annum, strictly confined to the summer months. The climate is very hot. (2) A broad belt running south from the eastern part of the Zoutpansberg nearly to the Olifants River and including the northern part of the Kruger National Park. This latter block is wetter, rainfall being over 15 inches per annum and the altitude from under 1,000 to 1,500 feet. The vegetation is taller and more mixed, but little information is available about it.

In the north-western block of Mopani veld, the vegetation is typically a short, fairly dense growth of shrubby *Copaifera mopane*, generally associated with a number of other trees and shrubs in a somewhat sparse and tufted grassveld. The trees and shrubs include:—

Copaifera mopane.
Acacia heteracantha.
A. nigrescens and others.
Combretum apiculatum.
Sclerocarya caffra.
Dichrostachys glomerata.
Cadaba termitaria.
Schotia transvaalensis.
Boscia rehmanniana.
Boscia albitrunca.
Cassia abbreviata var. granitica.
Commiphora spp.

Grewia spp.
Ximenia sp.
Lycium sp.
Terminalia prunioides.
Adansonia digitata.

The grass layer includes:—

- Anthephora pubescens.
- Brachiaria nigropedata.
- Bothriochloa insculpta.
- Eragrostis superba.
- Schmidtia bulbosa.
- Heteropogon contortus.
- Aristida uniplumis.
- Chloris myriostachya.
- Tricholaena monachne.
- Eragrostis denudata.
- Cenchrus ciliaris.
- Panicum maximum (patches).
- Digitaria eriantha var. stolonifera (patches).
- Neorautanenia sp.

but is usually reduced to *Eragrostis* sp. cf. *E. atherstonei*, together with annuals like *Aristida barbicollis* and *Enneapogon cenchroides.*

In parts, the Mopani is stunted and completely dominant; while in the main valleys the bush is more mixed and not dominated by Mopani. Here is the usual riverside growth of tall *Acacia karroo* and *Panicum maximum*, with more or less *Boscia rehmanniana*, *B. albitrunca*, *Acacia heteracantha*, *Commiphora pyracanthoides*, *Terminalia prunioides*, *Mundulea sericea* and thickets of *Acacia detinens*, *A. dulcis* and others, but in addition, such curiosities as *Sesamothamnus lugardii* and *Catophractes alexandri* occur, plants which are more important along rocky watercourses and koppies. Very little information is available at this stage, however, about these interesting variations. *Adansonia digitata*, the Baobab, occurs scattered all through this veld type. North of the Limpopo the Mopani veld develops into something very like forest, straight trees up to 30 feet high forming a closed canopy, and with little undergrowth.

16. Kalahari Thornveld.

There are two main subdivisions of this type:—

(*a*) Kalahari Thornveld proper.
(*b*) Vryburg Shrub Bushveld.

(*a*) *Kalahari Thornveld.*

Kalahari Thornveld proper occurring on deep loose sand over calcareous tufa. This is the more extensive in area and has four subdivisions:—

(1) North-eastern, in the Transvaal, transitional to bushveld. One form of this has been mentioned (p. 53) as occurring anomalously on turfy soil around Nietverdiend. The other occurs on sand around Pienaars River with outliers eastwards.

(2) Eastern, in the Western Free State, Western Transvaal and Vryburg and Mafeking divisions; an *Acacia giraffae*—savannah with the grasses of the Dry *Cymbopogon–Themeda* veld and some of those of the Bankenveld.

(3) Central, along the line Hopetown–Kimberley–Vryburg; an *Acacia giraffae* savannah with some of the grasses of the Dry *Cymbopogon–Themeda* veld and some of those of the western form.

(4) Western and north-western, west of the Asbestos, Kuruman and other hills northwards, and the most extensive variation; a generally very open savannah of *Acacia haematoxylon* and *A. giraffae* with desert grasses.

(*b*) *Vryburg Shrub Bushveld*, occurring on rocky soil. This covers most of Griqualand West and much of the southern part of Vryburg and Kuruman divisions. It has at least four sub-divisions:

(1) The *Tarchonanthus* veld of the Kaap Plateau, with many minor variations.

(2) The mixed *Tarchonanthus* veld of the Asbestos and Kuruman Hills.

(3) The mixed *Tarchonanthus–Rhus–Croton* veld of the Langeberg.

(4) The mixed *Tarchonanthus*–thorn veld of the Kimberley plains and koppies.

Each of these variations shows minor variations, both from south to north, from the edge of the dry valley of the Orange River to the wetter country northwards, and from geological formation to geological formation. Some of these variations will certainly have to be separated as distinct veld types; but the geological structure of Griqualand West and the surrounding divisions is so complex that the mapping of them would be a very lengthy procedure.

(1) *The North-eastern Form of the Kalahari Thornveld.*—The main block of this veld occurring on sand lies in the neighbourhood of Pienaars River Station. It is not typical, being transitional both to the Vryburg Shrub Bushveld and the Mixed Bushveld, and has suffered much from mismanagement.

Acacia giraffae is the largest tree, in parts rare, elsewhere fairly common, associated with—

Acacia heteracantha.
A. detinens.
A. gillettiae.
Tarchonanthus camphoratus var. litakunensis.
Grewia flava.
Boscia albitrunca.
Dichrostachys glomerata.
Mundulea sericea.

and a little *Euclea undulata*, *Ziziphus mucronata*, *Royena pallens* and *Peltophorum africanum*. *Acacia heteracantha*, *A. detinens*, *A. gillettiae* and *Dichrostachys* tend to develop into thickets, often with abundance of *Aloe davyana*.

The climax grasses appear to be—

Eragrostis superba.
Cymbopogon plurinodis.
Themeda triandra.
Elyonurus argenteus.
Heteropogon contortus.
Panicum coloratum.
Enneapogon scoparius.
Eustachys paspaloides.

with *Panicum maximum* under the trees, but to-day *Eragrostis* sp. cf. *E. atherstonei*, *Digitaria eriantha*, *Eragrostis pallens* (in patches) *Perotis indica*, *Trichoneura grandiglumis* and *Mosdenia phleoides* are more plentiful.

Patches of *Terminalia* veld occur, as they do along the north edge of the eastern variation of the Kalahari Thornveld in Kuruman and Vryburg divisions.

The eastern outliers on the southern edge of the Springbok Flats and in the Chalate Valley are more typical in being dominated by *Acacia giraffae*, to the extent of being almost a closed forest in parts, but still associated with bushveld species like *Terminalia sericea* and *Peltophorum africanum*.

(2) *The Eastern Form of the Kalahari Thornveld.*—This is generally an open savannah of *Acacia giraffae* in tall grass, though around Schweizer Reneke and south of the Vaal River it is fairly dense in parts; other trees and shrubs are rare. The rainfall ranges from 15 to 20 inches per annum

falling in summer. In spite of this marginal rainfall and the loose sandiness of the soil, extensive areas have in recent years been ploughed up in the Western Transvaal. Crops are sometimes good, but mealies growing amongst camelthorn trees are ecologically a startling and alarming sight. In the Vryburg division, ancient cultivation has, over large areas, practically removed the trees, leaving what is virtually grassveld, often dotted with *Grewia flava* and stunted *Royena pallens*. The only tree of general occurrence and importance is *Acacia giraffae* 5.

In the grassveld constituent of this veld, the following are of general occurrence:—

Eragrostis lehmanniana	89,489
Anthephora pubescens	71,680
Themeda triandra	63,496
Setaria flabellata	51,819
Eragrostis atherstonei	34,119
Aristida graciliflora	24,174
Tragus koelerioides	23,691
Elephantorrhiza elephantina	8,608
Elyonurus argenteus	7,915
Eragrostis pallens	7,603
Aristida uniplumis	4,962
Pogonarthria squarrosa	3,951
Hermannia tomentosa	3,174
Cymbopogon plurinodis	3,087
Indigofera daleoides	2,716
Triraphis andropogonoides	2,614
Cyperus margaritaceus	2,560
Anthericum erraticum	2,246
Anthospermum rigidum	2,036
Aristida congesta	1,991
Cassia mimosoides	1,459
Hibiscus malacospermus var. purpureus	1,295
Rhynchosia adenodes	474
Barleria macrostegia	161
Eragrostis gummiflua	46
Tephrosia lupinifolia	13
Boophone disticha	1

Of less general occurrence are:—

Cynodon dactylon	34,280
Aristida diffusa var. burkei	7,367
Helichrysum paronychioides	7,079
Aristida mollissima	6,319
Schmidtia bulbosa	5,754
Eragrostis superba	3,670
Nolletia ciliaris	2,446
Tephrosia sphaerosperma	1,713
Cassia obovata	935
Cucumis naudinianus	882
Eragrostis chloromelas	853
Trichoneura grandiglumis	852
Helichrysum caespititium	700
Bolusia capensis	641
Kyllinga alba	641
Helichrysum zeyheri	619
Bulbostylis burchellii	204
Fimbristylis exilis	204
Stachys spathulata	204
Plinthus sericeus	92
Aristida meridionalis	84
Dicoma schinzii	71
Sericorema remotiflora	66
Tristachya rehmannii	58

and many more, the total number of species in the Relative Abundance Table being 199. This veld, therefore, is sparse, but the tufts are large.

(3) *The Central Form of the Kalahari Thornveld.*—(See Hutchinson, p. 412.) In this case the rainfall is only about 15 inches per annum, so the veld has not been disturbed by ploughing. The " purple " grasses of the Dry *Cymbopogon–Themeda* veld have fallen out, except *Themeda*, and been replaced by the " white " grasses of the Kalahari. *Themeda*, however, is the natural dominant, which mainly distinguishes this form from the western form, even though it is to be found to-day, as dominant, only on exceptionally well-cared for farms. Further overgrazing will in turn cause the " white " grasses to be replaced entirely by a uniform growth of *Schmidtia bulbosa*; this change can happen quite suddenly, in a few years. *Pentzia*

virgata and *Chrysocoma tenuifolia* are steadily invading, and to-day these Karoo bushes will be more important than they were 14 years ago when most of the data about this veld were collected.

Trees and shrubs of general occurrence are:—

Acacia heteracantha	1,724	Ziziphus mucronata	140
Lycium oxycladum	1,620	Acacia giraffae	124
Royena pallens	207	A. detinens	51
Rhus ciliata	203	Asparagus laricinus	9
Grewia flava	178	Acacia stolonifera	7
Lycium hirsutum	171	Ehretia rigida	5
Tarchonanthus camphoratus var. litakunensis	156		

The large size of *Acacia giraffae* makes it the dominant.

Of general occurrence in the grassveld constituent are:—

Eragrostis lehmanniana	57,600	Hibiscus marlothianus	4,362
Schmidtia bulbosa	29,646	Hermannia tomentosa	2,761
Eragrostis atherstonei	23,106	Rhynchosia confusa	2,746
Tournefortia tuberculosa	20,840	Cucumis naudinianus	2,316
Aristida uniplumis	17,043	Aristida graciliflora	1,992
Cassia obovata	16,202	Aristida meridionalis	1,857
Aristida barbicollis	11,740	Nolletia ciliaris	1,517
Elephantorrhiza elephantina	10,478	Gazania oxyloba	1,377
Arthrosolen polycephalus	9,757	Antizoma calcarifera	1,359
Anthephora pubescens	8,141	Aptosimum leucorrhizum	1,339
Aristida congesta	6,603	Sericorema remotiflora	1,208
Pentzia virgata	6,368	Salvia clandestina var. angustifolia	1,168
Pogonarthria squarrosa	6,301	Eragrostis obtusa	1,094
Dicoma schinzii	6,241	Aptosimum marlothii	1,077
Harpagophytum procumbens	5,899	Solanum supinum	898
Themeda triandra	5,180	Pollichia campestris	725
Aristida diffusa var. burkei	4,827	Cynodon incompletus	618
Commelina africana	4,674	Othonna pallens	592
Chrysocoma tenuifolia	4,554	Geigeria passerinoides	448
Hermannia comosa	4,509	Pentzia viridis	428

and many more, a rich flora, with the forbs and annuals playing an important part. The cover, however, is sparse, the grasses being tall and tufted. *Geigeria passerinoides* is relatively scarce; other poisonous plants, which may be locally common, include *Geigeria brevifolia*, *G. obtusifolia* and *Urginea burkei*. The total number of species in the Relative Abundance Table is 270.

(4) *The Western Form of the Kalahari Thornveld.*—(See King, Fig. 138.) This, the typical form, is an extremely open savannah of *Acacia giraffae* and *A. haematoxylon*, except along rivers and near ranges of hills and mountain, where besides greater quantities of these two species, *Boscia albitrunca*, *Grewia flava*, *Lycium hirsutum* and *Rhigozum trichotomum* are important. The grasses are tufted and entirely of the " white " type, mostly *Aristida* spp. and *Eragrostis* spp., with the silvery *Aristida uniplumis* conspicuous. On dunes and in valleys, *Aristida namaquensis*, *Danthonia glauca*, *Monechma incanum* and *Crotolaria virgultatis* may be important. In the southern part of this veld type, in Gordonia, outcrops of calcareous tufta and silcrete are occupied by Arid Karoo or Orange River Broken Veld,

while in the valleys of the Langeberg and parallel ranges of hills there is in parts, a strong invasion by *Eriocephalus ericoides*, resulting in a Karoo very similar to that of sandy patches in the Central Upper Karoo and False Karoo. The annual *Schmidtia kalahariensis* is sometimes extremely abundant in tramped-out areas after good rains; and the poisonous *Dipcadi glaucum* is common in parts along the foot of the Langeberg.

The sparse tuftedness of the grass and the looseness of the virtually bottomless sand, make this veld extremely vulnerable to grazing pressure, and it is indeed fortunate that the absence of surface water has kept it so largely uninhabited.

A well developed example of this veld is that at Witsand, where it varies from a dense growth of *Acacia haematoxylon* to an open growth of large *A. giraffae*; unfortunately the grass has been grazed to extinction. Another good sample occurs as an outlier in the angle between the Vaal and Riet rivers in Kimberley division, and there are others in valleys of the Asbestos Hills, e.g. south-west of Griquatown.

(*b*) *Vryburg Shrub Bushveld.*

The variations of this veld type are legion, but in general it is a fairly dense bushveld composed of shrubs, and sometimes small trees, in a mixed grassveld. The principal shrub all through is *Tarchonanthus camphoratus* var. *litakunensis*, associated with the following (and other) species:—

Olea africana.
Acacia heteracantha.
Tarchonanthus minor.
Rhus ciliata.
R. ciliata forma.
R. pyroides.
R. lancea.
R. undulata var. burchellii.
R. dregeana.
Euclea ovata.
Royena pallens.
Grewia flava.
Boscia albitrunca.
Gymnosporia buxifolia.
Rhigozum obovatum.
R. trichotomum.
Ehretia rigida.
Ziziphus mucronata.
Acacia karroo.
A. detinens.
Croton gratissimus.
Buddleja salicifolia.
Lebeckia macrantha.

The grass is by nature tall, dominated by *Themeda triandra* and *Cymbopogon plurinodis*, with much *Aristida diffusa* var. *burkei*, *A. uniplumis* vars., *Eragrostis lehmanniana*, *Eustachys paspaloides*, *Heteropogon contortus*, *Chrysopogon montanus* var. *tremulus* and *Digitaria eriantha*; but by the process of deliberate overgrazing known as " maktrap ", it has been broken down to *Aristida diffusa* var. *burkei*, *Eragrostis lehmanniana*, *Aristida congesta*, *A. barbicollis* and *Enneapogon brachystachyus*, sometimes even to *Enneapogon* alone, which has permitted the Karoo to invade from the south and to increase. Although this change may be considered desirable for the sort of sheep farming practised, the accompanying increase in the poisonous *Geigeria passerinoides* and *Ornithoglossum viride* is undesirable from any point of view. The Karoo invasion is proceeding rapidly and is sometimes accompanied by the development of thickets of less valuable shrubs and trees like *Rhus ciliata*, *Acacia detinens* and *A. heteracantha*, while valuable fodder-shrubs like *Tarchonanthus minor* are suffering the usual fate of useful plants—being killed out. *Aloe grandidentata* sometimes becomes common.

So much information has been collected about this veld type and its variations that it cannot be handled in a hurry; at this stage, therefore, they will be described only in general terms. It is typically the veld of

Griqualand West, but extends well into Taungs, Vryburg and Kuruman divisions, especially along the Kuruman Hills and the Langeberg and Korannaberg; it does not cross the Orange River and extends only a short distance eastwards into the Western Free State and Western Transvaal.

(1) *Tarchonanthus—Veld of the Kaap Plateau.*—The Kaap Plateau is very flat, sloping gently up from 4,100 feet along the well marked escarpment in the east to c.4,700 feet along the foot of the Asbestos Hills in the west. The rainfall, coming in summer, ranges from 10 inches in the south to c.18 inches in the north, but is very erratic. In summer, the climate is hot, in winter, very frosty. This veld type has three main variations:—

(i) Dense *Tarchonanthus*-veld on the calcareous tufa which covers most of the dolomite of which the Kaap Plateau consists. Associated with the dominant *Tarchonanthus camphoratus* var. *litakunensis* are: *Rhus ciliata, R. pyroides, R. lancea, R. ciliata, forma, Royena microphylla, R. pallens* and *Euclea ovata*, scattered or growing together in bush clumps. (See Hutchinson, p. 417, facing p. 481; King, Figs. 269, 270; Adamson, Photo 12.)

In parts this veld is more open and dominated by *Olea africana*, forming a parkland. On the low dykes (are) of more crumbly tufa than the generally slabby tufa of the flats, and at the edges of the numerous and remarkable large and small pans and shallow drainage channels, *Themeda* has persisted better than elsewhere; while the presence of underground water in such places permits the growth of *Acacia karroo* and *Rhus lancea*. Here and there on an unoccupied or well managed farm one can find a pan that shows traces of a tall growth of *Themeda triandra, Miscanthidium sorghum* and sedges around its margin, with an interesting zonation of smaller plants towards the middle, suggesting that the grazing potentialities of these pans are far greater than the usual present day expanse of glaring white calcerous clay and gravel would lead one to suppose.

What little soil there is on the tufa is of a black, turfy nature, and this form of the Vryburg shrub bushveld is the sweetest, such grasses as *Digitaria, Chrysopogon* and *Eustachys* finding a safe refuge in the crevices between the slabs of tufa. On the other hand, *Geigeria passerinoides* is here the most abundant, a stunted form which is reputed to be the most dangerous to sheep. Here and there one gets the impression that the turfy soil may once have formed a continuous cover over the tufa; but, if so, it has disappeared with surprising completeness.

(ii) *Open Tarchonanthus–Rhus ciliata-Veld* on dolomite, which is usually covered with a layer of dark brown sandy soil or of red sand and acid gravel. The grass in this variation is of a coarser, wirier and more tufted nature and tramps out readily to *Aristida* spp., and the bush is more open. It occurs scattered over the Kaap Plateau, but is most extensive along the eastern foot of the Asbestos Hills, merging northwards into the eastern form of the Kalahari thornveld. (See Hutchinson, p. 413.)

(iii) *Dense Mixed Shrub Bushveld* along the eastern edge of the plateau on bare dolomite, and on the rugged escarpment itself. Besides the trees and shrubs mentioned above, the following occur: *Celtis kraussiana, Ficus ingens* (its white trunk often pressed flat against the face of a krantz), *Buddleja salicifolia,* *Lachnopylis gracilis, Nymania capensis, Asparagus retrofractus, Gymnosporia ilicina,* and *Cadaba juncea,* with the bushy *Salvia namaensis, Senecio longiflorus* and *Melianthus comosus*; while such succulents as *Aloe hereroensis, Cotyledon decussata* and *Kalanchoe pyramidalis* are sometimes conspicuous. *Cenchrus ciliaris* is the dominant grass, with much *Sporobolus fimbriatus, Chrysopogon, Cymbopogon plurinodis, Aristida diffusa* var. *burkei, Digitaria eriantha, Eragrostis lehmanniana, Heteropogon contortus* and *Fingerhuthia africana.* Thickets of *Acacia detinens, A. heteracantha* and *A. karroo* tend to form. Groves of fine, tall *Acacia karroo* occur around some of the fountains. (See Hutchinson, p. 432.)

(2) *Mixed Tarchonanthus Veld of the Asbestos and Kuruman Hills.*—(See Hutchinson, p. 412.) This occurs on the acid banded ironstone and Ongeluk lava of the hills, clinking stony country, and has a very rich flora: as has been mentioned (p. 19), a single list contained no less than 302 species. It is dominated by *Tarchonanthus minor,* rather than by *T. camphoratus* var. *litakunensis,* together with the following:—

Olea africana.
Rhus ciliata.
R. dregeana.
Lebeckia macrantha.
Euclea ovata.
Rhigozum obovatum.
Gymnosporia buxifolia.
Putterlickia pyracantha (especially southwards).
Rhus undulata var. burchellii (especially southwards).
Euclea undulata (especially southwards).
Rhigozum trichotomum (especially southwards).
Grewia flava.

This bush is more open than that of the Plateau, sometimes very sparse, especially southwards, where *Rhus undulata* var. *burchellii* and *R. dregeana* become the principal shrubs. Northwards, the grass is sourer, with a Bankenveld affinity, including such species as:—

Schizachyrium semiberbe.
Andropogon amplectens.
A. schirensis.
A. schinzii.
Brachiaria serrata.
and sometimes
Hyparrhenia hirta.
as well as the usual
Anthephora pubescens.
Themeda triandra.
Heteropogon contortus.
Eragrostis lehmanniana.
Aristida diffusa var. burkei.
Eustachys paspaloides.
Cymbopogon excavatus.
Elyonurus argenteus.
Trichoneura grandiglumis.
Rhynchelystrum repens.
Eragrostis curvula.

Sporobolus fimbriatus.
Cymbopogon plurinodis.
Fingerhuthia africana.
Panicum stapfianum.
Schmidtia bulbosa.

Southwards, *Aristida diffusa* var. *burkei, Eragrostis lehmanniana, Enneapogon scoparius* and *Fingerhuthia africana* become more important, with *Digitaria smutsii* dominant in protected places, whitening the black volcanic hills. Outliers of this veld on stony outcrops and hills in the Vryburg–Mafeking neighbourhood link it with the Bankenveld and Waterberg Sour Bushveld; while southwards, and in stony parts of the valleys between the Asbestos Hills and the Langeberg, it merges into the Orange River Broken Veld with an increase in the proportion of such species as

Acacia detinens, Rhigozum obovatum, R. trichotomum, Nymania capensis, Euryops multifidus, Lycium spp. and *Lebeckia macrantha,* and of Karoo species such as *Pentzia virgata, P. globosa, Aptosimum marlothii, Nestlera humilis, Pteronia glomerata, P. sp. cf. P. acuta* and *Arthrosolen polycephalus.*

Geigeria passerinoides, of a more luxuriant form than that of the Kaap Plateau, is often abundant on the Rooirandjies and a serious hindrance to sheep farming. There is a good deal of soil erosion in the red sandy loam of the numerous little valleys, and there is no doubt that the bare stoniness of the hills is the result of sheet-erosion, even though that same stoniness gives the vegetation a secure foothold.

(3) *Mixed Tarchonanthus–Rhus–Croton Veld of the Langeberg.—*

This veld is generally similar to 16 (*b*) (2), though of an appalling rockiness, rather than stoniness; but on this relatively high, continuous and very steep sided, north to south trending mountain range, there is a well marked aspect difference. The western slopes, from a distance, appear to be bare rock, but actually are well covered with *Croton gratissimus,* a tree whose leaves are much the same colour as the pinkish and greenish quartzites of which the mountain is composed. Associated with *Croton* are *Euphorbia avasmontana, Tarchonanthus minor, Rhus undulata* var. *burchellii, Euclea undulata, Sarcostemma viminale* forma and *Putterlickia pyracantha,* with *Aristida engleri, A. diffusa* var. *burkei* and *Heteropogon contortus* the dominant grasses. The eastern slopes lack, as important species, *Croton, Euphorbia* and *Sarcostemma,* but have the other shrubs more plentifully, in a better mixed grassveld; while in the kloofs, e.g. at Bergenaarspad, is almost a forest of *Buddleja salicifolia.*

In this " forest " the silence of the arid regions is broken by a multitude of bird-calls.

(4) *Mixed Tarchonanthus Thornveld.*—This variation or complex of variations, occurs in the same area as the Central form of the Kalahari thornveld, but on hard, red, sandy loam on calcareous tufa or directly on dolerite, Ventersdorp lava and other rocks, and on rocky hills, the Kalahari Thornveld occupying the loosely sandy parts. As the name suggests, the thorns are important, especially *Acacia heteracantha* and *A. stolonifera* together with *Tarchonanthus camphoratus* var. *litakunensis, Ziziphus mucronata, Ehretia rigida, Royena pallens, Rhus pyroides, Acacia detinens, A. karroo* and other species of shrubs and trees. On the flats the grass is of mixed type with *Themeda,* but usually reduced to *Eragrostis* spp. *Digitaria eriantha, Sporobolus fimbriatus, Aristida uniplumis, A. diffusa* var. *burkei* and *A. barbicollis*—sometimes even to a pure stand of *Aristida barbicollis. Rhus ciliata* tends to develop into thickets. On the rocky hills, besides the trees and shrubs of the flats, *Buddleja salicifolia* and *Rhigozum obovatum* are important, with *Cenchrus ciliaris, Themeda triandra, Heteropogon contortus, Cymbopogon plurinodis, Eustachys paspaloides, Fingerhuthia africana* and *Enneapogon scoparius,* plus the grasses just mentioned. Forbs and annuals are numerous and important, but *Geigeria passerinoides* is less common, even on the calcareous tufa, than it is on the Kaap Plateau.

Where the calcareous tufa is not covered with sand, the vegetation is sometimes *Tarchonanthus* veld similar to that of the Kaap Plateau; but more commonly such places are False Karoo dotted with a few big shrubs, mainly *Royena pallens,* probably because the *Tarchonanthus* has been chopped out for firewood.

Southwards and westwards there is a transition to Orange River Broken Veld and the Karoo type of hill vegetation, while northwards there is a good transition to bushveld, starting near Barkly West on the rocky ridge between the Harts and Vaal Rivers and continuing both along the small rocky escarpment on the east side of the Harts River, and along the scattered hills towards Potchefstroom. Eastwards, the vegetation of the widely scattered koppies of the Western Free State links this veld with the denser and more mixed bushveld of the Bloemfontein koppies and the low escarpment running north north-east from Bloemfontein.

17. Kalahari Thornveld Invaded by Karoo.

In this region we find the grassveld constitutent of the thornveld being replaced by Karoo, where it has been reduced by grazing mismanagement. This Karoo invasion takes various forms:—

(1) On the deep sand of the western form of the Kalahari thornveld *Eriocephalus ericoides* invades and *Geigeria brevifolia, G. obtusifolia* and *Salvia radula* thicken up.

(2) On rocky hills and on calcareous tufa, a fully mixed Karoo flora invades. The species include:

Pentzia globosa.
P. virgata.
Nestlera humilis.
Plinthus karrooicus.
Barleria rigida.
Ruschia caninotata.
Salsola glabrescens.
Chrysocoma tenuifolia.
Aster muricatus.
Osteospermum muricatum.
Pegolettia retrofracta.
Pteronia glomerata.
Aristida obtusa.
Enneapogon brachystachyus.
Eragrostis bicolor.
Lasiocorys capensis.
Salvia clandestina var. angustifolia.
Stachys spathulata.
Asparagus stipulaceus.
Limeum aethiopicum.
Nenax microphylla.
Thesium hystrix.
Aptosimum marlothii.
Aptosimum leucorrhizum.
Sutera atropurpurea.
Tribulus terrestris.
Zygophyllum microphyllum.

This is a fairly comprehensive list, including elements both of the Central Upper Karoo and of the Arid Karoo and Orange River Broken Veld.

(3) On the hard red sandy loam of the Kimberley area, *Chrysocoma tenuifolia* is the principal invader, while the local *Chrysocoma* sp. (=A. 6812H) thickens up.

(4) On sandy calcareous tufa, besides the Karoo bushes listed, *Othonna pallens*, *Euryops asparagoides*, *Arthrosolen polycephalus* and sometimes *Psilocaulon absimile* also become common.

18. Mixed Bushveld.

Like the Vryburg Shrub Bushveld, this veld type is a more than Daedalian maze of variations and transitions. [See Hutchinson, pp. 386, 387 (Koppies), 388; facing p. 417 (Nylstroom river banks); Reynolds, Pl. 59; White, Dyer and Sloane, Figs. 1046, 1047; Marloth II, 2, Fig. 144 (Terminalia Veld.]

Within this veld type, Irvine recognizes two main variations: (1) *Combretum apiculatum* Veld. The bush consists of small trees, quite dense and sometimes almost scrub-forest. (2) Mixed *Terminalia–Dichapetalum* veld, occupying the sandy plateau between the Matlabas and Mogol Rivers, the sandy northern, western and eastern slopes and valleys of the Waterberg, thence extending along the Crocodile–Elands valley and along the sandy ridge which bisects the Springbok Flats, with outliers at Zebediela, in the Olifants River valley in the Groblersdal district and along the northern foot of the eastern part of the Zoutpansberg. The difficulties caused by the presence of *Dichapetalum cymosum* (Gifblaar) demand that this variation will have to be mapped in detail later as a separate veld type. This is rather a tree savannah, usually fairly dense and up to 30 feet tall.

18 (1) (*a*) *Combretum apiculatum Veld* with a variation (*b*) *Combretum apiculatum–Pterocarpus rotundifolius Veld.*

In Irvine's words: " These veld types cover some 6,800 square miles at an elevation of 2,500–3,500 feet and receive a rainfall of 14–25 inches. Although the soil throughout is shallow, the latter veld type occurs on areas where the soil is very shallow indeed with impeded drainage. The underlying rocks are granite, sandstone, quartzite and shale, covered by a shallow layer of gritty yellow-grey sandy loam on ouklip ."

(*a*) *Combretum apiculatum Veld.*—" The bush is very uniform, and rather dense, *Combretum apiculatum* being dominant throughout, with a small admixture of several other bushes and trees, e.g. *Acacia caffra*, *Combretum imberbe*, *Dichrostachys glomerata*, *Grewia* spp., *Lannea discolor* and *Sclerocarya caffra*, sometimes also *Albizzia anthelmintica* and *Kirkia acuminata*. Many of the grasses are sweet. The principal veld species are *Aristida barbicollis*, *Digitaria eriantha* var. *stolonifera*, *Eragrostis* sp. and *Schmidtia bulbosa*. Less abundant species are *Anthephora pubescens*, *Aristida uniplumis*, *Brachiaria nigropedata*, *Eragrostis superba*, *Heteropogon contortus* and *Themeda triandra*. *Elyonurus argenteus* is common in places ."

(*b*) *Combretum–Pterocarpus Veld.*—" This veld is a dense uniform mixture of these two bushes, less varied than the *Combretum* veld and with a sourer type of grass. The bush includes much *Grewia* spp. and a good deal of *Dichrostachys glomerata* and *Terminalia sericea*. The commonest grasses are *Aristida barbicollis*, *Digitaria eriantha* var. *stolonifera* and *Eragrostis* sp. cf. *E. atherstonei*, with much *Anthephora pubescens*, *Aristida graciliflora*, *Brachiaria nigropedata*, *Eragrostis chalcantha*, *Heteropogon contortus* and *Schmidtia bulbosa*. There is more *Elyonurus* than in pure *Combretum* veld, but little *Themeda*. The soil is very shallow, the ouklip being frequently exposed on the surface of the ground ."

(2) *Mixed Terminalia–Dichapetalum Veld.*

Irvine recognizes four variations of this veld:—

(*c*) *Terminalia* Veld, proper.
(*d*) *Combretum–Terminalia* Veld.
(*e*) *Sclerocarya–Burkea* Veld.
(*f*) *Burkea* Veld.

Dichapetalum occurs generally in (*e*) and (*f*), only patchily in (*c*) and (*d*). Soils are more or less sandy and are deep, on quartzites, shales, sandstones, granite and acid lavas.

(*c*) *Terminalia Veld Proper.*

This is a more or less dense, failry tall growth of bush on deep, loose sand, dominated by *Terminalia sericea* (up to 25 feet high), *Ochna pulchra* and *Burkea africana*, with a scanty undergrowth of smaller bushes, varying in species from place to place. *Grewia flava* is also important. The grass sward is inclined to be open and tufted, many of the species being coarse and wiry. The principal grasses are *Eragrostis pallens* and *Loudetia simplex* with much *Schmidtia bulbosa, Aristida uniplumis* and *Brachiaria nigropedata.*

(*d*) *Combretum–Terminalia Veld.*

" This veld type merges into *Combretum apiculatum* veld on the one hand and *Terminalia* veld on the other. It exhibits a fairly dense growth of *Burkea africana*, tall *Combretum apiculatum, Terminalia sericea* and *Pterocarpus rotundifolius*, with much *Grewia flava, G. kwebensis* and other *Grewia* spp., *Boscia rehmanniana* and *Mundulea sericea* and more scattered *Acacia arabica* var. *kraussiana.* The grass is dominated by *Schmidtia bulbosa* and *Digitaria eriantha* var. *stolonifera* with much *Brachiaria nigropedata, Eragrostis* sp. and *Aristida diffusa* var. *burkei.* There is a good deal of the coarse, wiry, sandveld grass, *Eragrostis pallens*, where the soil is more sandy. "

In both these veld types, where *Burkea africana* and *Ochna pulchra* occur together, *Dichapetalum cymosum* is likely to be present.

(*e*) *Sclerocarya–Burkea Veld.*

" This covers some 440 square miles on the deep red sand of the lower slopes of the Waterberg between the Matlabas and Mogol Rivers. The rainfall is 17–21 inches and the altitude 3,000–3,500 feet. The rock is quartzite, sandstone and granite. The bush is dominated by*Burkea africana* and *Sclerocarya caffra*, with much *Peltophorum africanum* and *Grewia flava*, and, less frequently, *Terminalia sericea, Ochna pulchra* and *Combretum apiculatum.* Much of the grass is of a coarse nature, as might be expected from the soil, the most abundant grasses being *Eragrostis pallens, Loudetia simplex* and *Schmidtia bulbosa. Eragrostis* sp.cf. *E. atherstonei, Aristida* sp. cf. *A. graciliflora* and *A. curvata* are common, while *Brachiaria nigropedata* and *Digitaria* spp. are to-day occasional, although there is reason to believe that the per cent. of these grasses present used to be higher. The dangerous poisonous plant, *Dichapetalum cymosum* (gifblaar) occurs very frequently and constitutes a serious menace to stock grazing this veld ."

(*f*) *Burkea Veld.*

" This veld covers about 300 square miles adjoining the *Sclerocarya*-veld on the north. The rainfall is 17–21 inches. The soil is deep, grey-brown sand, overlying shales, sandstones and quartzites, and the altitude is 3,000–3,500 feet. The principal species are *Burkea africana* and *Combretum zeyheri* with much *Protea* sp. and a good deal of *Ochna pulchra* and *Sclerocarya caffra.* The grass is somewhat wiry, although dominated by *Digitaria*, the principal species being *Digitaria eriantha* var. *stolonifera, Aristida graciliflora, Eragrostis* sp.cf. *E. atherstonei* and *Schmidtia bulbosa*, with much *Brachiaria nigropedata, Loudetia simplex* and *Schizachyrium semiberbe. Panicum maximum* is plentiful under the trees."

(*g*) *Acacia nigrescens–Combretum apiculatum–Kirkia wilmsii Veld.*

The eastern part of the mixed bushveld, in and between Olifants and Steelpoort valleys, is of rather a different type from the rest, very mixed as regards bush and with *Kirkia wilmsii* playing an important part. It may be characterized as *Acacia nigrescens–Combretum apiculatum–Kirkia wilmsii* veld; little is known about it. Much of this country is norite (Irvine includes it in the Turfveld), and the grass tends to be of sweeter type than it does on the generally acid rocks of the rest of the mixed bushveld, but no details are available about it. In the valleys we find a dense bush showing affinities with the dense valley scrub and the Arid Lowveld; it will probably have to be separated as sweet bushveld, related to Arid Lowveld rather than to the Arid Sweet Bushveld of the Limpopo valley. Altitude ranges from 2,000 to 3,500 feet above the sea, and rainfall from 17 to 25 inches per annum. The climate is hot.

Generally occurring shrubs and trees include:—

Acacia nigrescens.
Combretum apiculatum.
Kirkia wilmsii
Sclerocarya caffra.
Balanites maughamii.
Ziziphus mucronata.
Schotia brachypetala.
Euphorbia cooperi.
E. ingens.
E. tirucalli.
E. excelsa (local).
Acacia heteracantha.
A. detinens.
A. dulcis.
A. senegal.
A. karroo and other spp.
Combretum transvaalense.
Albizzia anthelmintica.
Peltophorum africanum.
Aloe spp.
Spirostachys africana.
Sterculia rogersii.
Commiphora spp.
Rhus gueinzii and other spp.
Olea africana.
Boscia rehmanniana.
Ptaeroxylon obliquum.
Terminalia sericea (sandy parts).
T. prunioides.
Mundulea sericea.
Tarchonanthus camphoratus.
Grewia monticola and other spp.
Dichrostachys glomerata.
Gymnosporia senegalensis.
Cadaba termitaria.
Bolusanthus speciosus.
Croton sp.
Euclea undulata.
Strychnos sp.

with *Acacia heteracantha* dominant on ancient fallows, as usual.

(*h*) *Open Sclerocarya Veld.*

This variation, like the Sclerocarya–Burkea Veld [18 2 (*e*)], is rather sourer, or at least harder, as regards its grasses, than is usual in the mixed bushveld, in spite of receiving as little as 14 inches of rain per annum in parts. It occurs (i) on the gentle northern slopes of the Pietersburg Plateau, under a rainfall of 14–15 inches per annum on granite; (ii) on the rolling granite country of the Elands River valley north of Rustenburg, under a rainfall of about 20 inches per annum.

(i) Here it occurs on wide ridges between thorn-filled valleys, and is an open savannah of small *Sclerocarya caffra* and *Peltophorum africanum* with some *Gymnosporia senegalensis*, *Grewia flava*, *Acacia permixta* and *Clerodendrum glabrum*, and a few other species as rareties. The grass is a curious mixture, including *Digitaria eriantha* var. *stolonifera*, *Eragrostis* sp. cf., *E. atherstonei*, *Themeda triandra*, *Rhynchelytrum repens*, *Pogonarthria squarrosa*, *Aristida barbicollis*, *A. graciliflora* and *Trichoneura grandiglumis* with smaller quantities of *Andropogon schirensis*, *Schmidtia bulbosa*, *Heteropogon contortus*, *Panicum coloratum*, *Cymbopogon plurinodis* and *Tricholaena monachne*, i.e. hard and wiry more than sour in the ordinary sense.

The thornveld of the shallow valleys is transitional to the Arid Sweet Bushveld; important trees and shrubs include:—

Acacia heteracantha.
Dichrostachys glomerata.
Grewia monticola.
Peltophorum africanum.
Acacia arabica var. kraussiana.
Gymnosporia senegalensis.
Grewia flava.
Combretum apiculatum (rare).
Heeria reticulata.
Commiphora mollis.
Ziziphus mucronata.
Sclerocarya caffra.

with the following grasses:—

Heteropogon contortus.
Digitaria eriantha var. stolonifera.
Eragrostis sp. cf. E. atherstonei.
Cymbopogon plurinodis.
Aristida graciliflora.
Schmidtia bulbosa.
Brachiaria nigropedata.
Themeda triandra.
Panicum coloratum.

and others.

(ii) This variation of the Open Sclerocarya veld is a good deal sourer, often on very shallow, gritty soil on ouklip. Trees and shrubs include:—

Sclerocarya caffra.
Dichrostachys glomerata.
Rhus gueinzii.
Acacia arabica var. kraussiana.
Peltophorum africanum
Euclea undulata.
Acacia heteracantha.
Grewia sp.
Vitex zeyheri.

with, in the grassveld constituent:—

Loudetia simplex.
Digitaria eriantha var. stolonifera.
Anthephora pubescens.
Elyonurus argenteus.
Andropogon schirensis.
Cymbopogon excavatus.
Bulbostylis burchellii.
Brachiaria nigropedata.
Heteropogon contortus.
Eragrostis superba.
Brachiaria serrata.
Cymbopogon plurinodis.

(*j*) *Dombeya rotundifolia–Acacia rehmanniana Veld.*

These variations (*g*) and (*h*) of the mixed bushveld merge easily into variation (*j*) on the gentle western aspect of the Drakensberg ridge south of Louis Trichardt and round the northern edge of the Pietersburg Plateau. This likewise occurs on granite, and, in turn merges easily into the Sourish Mixed Bushveld of the top of the escarpment. There is a rapid decrease in rainfall from east to west, and to a lesser degree from south to north, so these veld types form narrow, ill-defined belts. This variation (*j*) is a fairly dense savannah of trees and shrubs in tall, mixed grass. The trees include:—

Dombeya rotundifolia.
Acacia rehmanniana.
Balanites maughamii.
Peltophorum africanum.
Heeria reticulata.
Pappea capensis var.
Ziziphus mucronata.
Acacia robusta.
Boscia rehmanniana.
Sclerocarya caffra.
Acacia heteracantha.
Combretum holosericeum.

The shrubs include:—

Gymnosporia senegalensis.
Ehretia rigida.
Ormocarpum trichocarpum.
Grewia monticola.
Gymnosporaia buxifolia.
Mundulea sericea.
Dichrostachys glomerata.
Balanites australis.
Grewia flava.
Commiphora pyracanthoides.
Acacia permixta (important in patches).
Pterocarpus rotundifolius.
Euclea undulata.

The grassveld constituent is of normal Mixed Bushveld type, including:

Themeda triandra.
Eragrostis superba.
Brachiaria nigropedata.
Urochloa sp.
Sporobolus nitens.
Schmidtia bulbosa.
Panicum coloratum.
Bothriochloa insculpta.
Cymbopogon plurinodis.
Eragrostis sp.
Heteropogon contortus.
Aristida graciliflora,

with *Panicum maximum* under the trees, and tramping out to:—

Eragrostis sp.cf. E. atherstonei.
Aristida barbicollis.
Digitaria eriantha var. stolonifera.
Trichoneura grandiglumis.
Schmidtia bulbosa.
Rhynchelytrum repens.

On dome-shaped granite koppies occurring in this veld, *Euphorbia ingens* and *E. cooperi* are often conspicuous with much *Cenchrus ciliaris.*

19. SOURISH MIXED BUSHVELD.

(See Hutchinson, p. 411; Reynolds, Pl. 31, 51, 61.

This is a rather more clearly defined veld type than is the Mixed Bushveld, occupying an irregular belt on the gentle slopes to the mountains, between the sour types (both grassveld and bushveld) and the mixed types of the plains and valleys. It is generally a rather open savannah with *Acacia caffra* the dominant tree, in a fairly tall and dense grassveld dominated by *Cymbopogon plurinodis, Themeda triandra, Elyonurus argenteus* and *Hyparrhenia* spp. Soils are sandy loam and rainfall ranges from 14 to 25 inches per annum.

The principal trees and shrubs are:—

Acacia caffra.
A. karroo.
A. robusta.
A. heteracantha.
Rhus gueinzii.
Grewia spp.
Peltophorum africanum.
Acacia gerrardii.
Pappea capensis var.
Dichrostachys glomerata.
Dombeya rotundifolia.
Combretum zeyheri.
Sclerocarya caffra.
Ziziphus mucronata.
Burkea africana.

The principal grasses are:—

Cymbopogon plurinodis.
Themeda triandra.
Elyonurus argenteus.
Heteropogon contortus.
Aristida canescens.
Eragrostis superba.
Brachiaria nigropedata.
Anthephora pubescens.
Aristida graciliflora.
Panicum maximum (under trees)

breaking down to *Eragrostis* sp. cf. *E. atherstonei, Digitaria eriantha* var. *stolonifera* and *Aristida barbicollis.*

The north-eastern part of this veld type, north of the Chunes mountains on granite, differs in having wirier grasses. Besides those mentioned as being typical, the following are important:—

Eragrostis sp. cf. E. heteromera.
Pogonarthria squarrosa.
Trichoneura grandiglumis.
Setaria sp.
Eragrostis chloromelas.
Schizachyrium semiberbe.
Sporobolus stapfianus.
Alloteropsis semialata var. ecklonii.
Tristachya hispida.
Loudetia simplex.
Digitaria monodactyla.

Andropogon amplectens.
Trachypogon capensis.
Triraphis andropogonoides.
Andropogon sp.
Eragrostis gummiflua.

There is a suggestion of the North-Eastern Mountain Sourveld about this mixture, but it is still bushveld, with the following trees and shrubs:—

Acacia caffra.
Combretum holosericeum.
Acacia sp.
Dombeya rotundifolia.
Peltophorum africanum.
Euphorbia ingens.
Acacia karroo.
A. gerrardii.
A. burkei.
A. permixta.
Faurea saligna.
Gymnosporia senegalensis.
Ficus natalensis.
Acacia robusta.
Schotia brachypetala.
Acacia davyi.
Dovyalis zeyheri.
Ormocarpum trichocarpum.
Royena sericea.
Carissa bispinosa.

and many more. In the gaps in the Drakensberg between the Chunes Mountains and the Zoutpansberg, the North-Eastern Mountain Sourveld is not developed at all; here this form of the Sourish Mixed Bushveld merges directly into the Lowveld Sour Bushveld of the eastern escarpment via a narrow belt, just at the edge of the escarpment, of *Faurea saligna* veld, which is not quite that of the Waterberg, too narrow to map, and best included in the Sourish Mixed Bushveld.

South of the Chunes Mountains, this veld type, like the Mixed Bushveld in this part, includes a good deal of *Kirkia wilmsii.*

20. Sour Bushveld.

(See Taljaard, Photos 73, 76, 77; Hutchinson, facing pp. 416. 417.

This is the veld of the bushveld mountains, the Waterberg having the biggest area of it. It is an open savannah of tall straight *Faurea saligna* trees in a tall, tufted, wiry, sour grassveld in the less rocky parts, a dense, mixed bushveld in the rugged parts. It is beautiful country, but hot in spite of its altitude of 4,000 to 5,000 feet above sea-level. On the quartzite, sandstone and shale of most of these mountains, the soil is of a sandy, rubbly nature, very poor and sour. Rainfall ranges from 25 to 35 inches per annum, falling in summer.

Typical trees and shrubs include:—

Faurea saligna.
Acacia caffra.
Protea caffra.
Chrysophyllum magalismontanum.
Dombeya rotundifolia.
Lannea discolor.
Vangueria infausta.
Combretum holosericeum.
C. zeyheri.
C. transvaalense.
C. apiculatum.
Rhus zeyheri.
Dovyalis zeyheri.
Rhamnus zeyheri.
Euclea lanceolata.
Kirkia wilmsii.
Croton gratissimus.
Ficus natalensis.
F. soldanella.
F. ingens.
Elephantorrhiza burkei.
Bridelia mollis.
Ochna pulchra.
Strychnos pungens.
Gymnosporia tenuispina.
Lachnopylis breviflora.
Tapiphyllum parvifolium.
Brachylaena rotundata.
Cassine burkeana.
Osyris compressa.

Grewia spp.
Burkea africana.
Gardenia spatulifolia.
Olea africana.
Diplorhynchus mossambicensis.
Pachystigma triflorum.
Pseudolachnostylis maprouneifolia.
Albizzia rhodesica.

and many more.

In patches on the slopes, on termitaria, and in sheltered kloofs (especially of the Magaliesberg), patches of near-forest develop. The principal species are:—

Mimusops zeyheri.
Clerodendrum glabrum.
Dovyalis zeyheri.
Celtis kraussiana.
Chaetacme aristata.
Euclea lanceolata.
Grewia occidentalis.
G. monticola and other spp.
Ficus natalensis.
F. pretoriae.
Carissa bispinosa.
Scolopia zeyheri.
Cassine burkeana.
Euphorbia ingens.
Acalypha glabrata var. pilosior.

plus

Rauvolfia caffra.
Halleria lucida.
Tricalysia lanceolata.
Apodytes dimidiata.
Buddleja salvifolia.
Trema guineensis.
Ilex mitis.
Pittosporum viridiflorum.
Rhus transvaalensis.
Rhoicissus sp.
Syzygium cordatum.

in the kloofs.

Along the rocky valleys, a thornveld composed of *Acacia caffra* is typical.

The grassveld constituent is a rich one floristically even if peculiarly useless for grazing, at least in its present condition. It is probable, however, that a wasteful combination of burning and selective grazing is largely responsible for this uselessness, through reducing the proportion of such useful grasses as *Themeda*. The principal species are:—

Schizachyrium semiberbe.
S. jeffreysii.
Elyonurus argenteus.
Setaria lindenbergiana (rocky places).
Loudetia simplex.
Andropogon amplectens.
Hyparrhenia dissoluta.
Trachypogon capensis.
Panicum natalense.
Brachiaria nigropedata.
Eragrostis curvula.
E. superba.
E. denudata.
Themeda triandra.
Sporobolus pectinatus.
Heteropogon contortus.
Microchloa caffra.
Digitaria eriantha var. stolonifera.
Aristida diffusa var. burkei.
A. transvaalensis.
A. spectabilis.
Pogonarthria squarrosa.
Bewsia biflora.
Rhynchelytrum setifolium.
R. repens (old lands).
Panicum maximum (under trees)
Enneapogon pretoriensis.
Urelytrum squarrosum.
Setaria perennis.

and many more, with a great wealth of forbs and bushy plants, including a few stragglers of the southern flora, e.g. *Cliffortia linearifolia*, *Pegolettia* *tenuifolia*, *Helichrysum kraussii* and *Erica drakensbergensis*, besides the important *Faurea saligna* and *Protea caffra*.

This veld is closely related to the more mountainous parts of the Lowveld Sour Bushveld, but is drier, less hot (especially in winter), and has not a general forest climax.

IIIA.—FALSE BUSHVELD TYPES.

21. FALSE THORNVELD OF EASTERN CAPE.

This veld type, on the undulating country along the foot of the mountains from Debe Nek to Somerset East, ranges to-day from Eastern Province Grassveld thickly sprinkled with dwarf *Acacia karroo* (thorn tree) to a dense, clumpy shrub bushveld indistinguishable from the upper margin of the Valley Bushveld, and even to a False Karroid Broken Veld. Rainfall ranges from about 16 to 25 inches per annum.

The vegetation of the ridges and plains is to be visualized as having been originally either Eastern Province Grassveld (as parts are to-day), or scrub-forest marginal to the high forest of the mountains, and separated from the Valley Bushveld by a zone of grassy thorn and bushclump-veld along the edges of the valleys. This zone would have been narrow along the steeper sided valleys, e.g. south of Alice, wide in the shallower valleys, e.g. south of Adelaide and Somerset East. The pattern of the vegetation below the mountains in this part is thus visualized as having been similar to that of the vegetation below the Drakensberg in the Transkei and Natal. There is no place for Karoo in this pattern.

It is this thorn-bushclump veld which is invading the grassveld and by reducing the grass cover and assisting erosion, is opening the way for the spread both of the less mesophytic Valley Bushveld and of the Central Lower Karoo, an alien to these parts. The result is False Karroid Broken Veld, an extremely poor substitute for the short, dense grassveld which belongs here.

Where the Eastern Province Grassveld still retains it dense *Themeda* sward, the thorn tree does not invade. When the sward has been broken down, by selective grazing, to the taller, more tufted *Digitaria–Sporobolus* stage, the thorn trees invade, not gradually, but in leaps. Apparently the seed, which is distributed by grazing animals, lies dormant until conditions suitable for its germination occur. Then seedlings either suffer mass mortality or survive in fair quantity and large areas become covered with little thorn trees all of the same size. Under some of them, bird-distributed shrubs, notably *Scutia myrtina*, establish themselves and grow into bush clumps. As these increase in size and develop their undergrowth of sweet *Panicum* spp., bare patches develop around them, both as a consequence of concentration of uncontrolled grazing and of direct competition with the grass. Then the surface soil becomes eroded away and gradually all trace of the original *Cymbopogon-Themeda* Veld disappears. On the eroded soil it returns with difficulty, even if the bush is chopped out, but it can be assisted by spreading the chopped bush over the bare surfaces, by reseeding and by resting the veld. Where erosion has not occurred, clearing of the bush will result in immediate recovery of the grass, even though reseeding to such species as *Themeda* and *Panicum stapfianum* may still be necessary to raise the succession beyond the *Digitaria-Sporobolus* stage.

Under conditions of excessive grazing pressure, the thorn tree invasion may be very dense and erosion may result at once. In all cases Karoo tends to invade, especially along the drier southern and western edges of the area; sometimes, also, *Berkheya* sp. and *Exomis microphyllum* become common. The Karoo is of Lower Central type, mainly *Pentzia incana* (*ankerkaro*), *Asparagus striatus*, *Indigofera patens*, *Hermannia candicans*, *Aster* sp. (=A. 12598), *Becium burchellianum* (in rocky places) *Selago triquetra* and *Ruschia vulnerans*. Along the foot of the mountains, where rainfall is higher, *Chrysocoma tenuifolia* is the principal Karoo invader, sometimes with *Selago corymbosa* and *Aster filifolius*, and rarely with *Pteronia incana*.

It is anticipated that Story will soon be able to throw light on this puzzling problem of thorn encroachment.

A typical sample of this false thornveld will have the following trees and shrubs, mostly in the bush clumps:—

Acacia karroo.
Scutia myrtina.
Capparis citrifolia.
Gymnosporia polyacantha.
G. capitata.
Ehretia rigida.
Carissa haematocarpa.
Allophylus decipens.
Azima tetracantha.
Sideroxylon inerme.
Buddleja salicifolia.
Cussonia spicata.
Grewia occidentalis.
Rhus longispina.
Cassine aethiopica.
C. papillosa.
Olea africana.
Ptaeroxylon obliquum.
Capparis oleoides.
Schotia latifolia.
Hippobromus pauciflorus.
Brachylaena ilicifolia.
Canthium ventosum.

Such species as *Buddleja salicifolia*, *Cussonia spicata*, *Grewia occidentalis*, *Cassine* spp., *Hippobromus* and *Canthium ventosum* are perhaps relicts of the old scrub forest.

The grassveld constituent of the sample will include:—

Sporobolus fimbriatus.
Digitaria eriantha.
Eragrostis curvula.
E. obtusa.
Cymbopogon plurinodis.
Themeda triandra.
Eragrostis chloromelas.
Panicum stapfianum.
Heteropogon contortus.
Setaria flabellata.
Eustachys paspaloides.
Aristida congesta.
Elyonurus argenteus (rarely).

In the Eastern Cape, the traveller has a constant reminder of how recent can be the changes in the vegetation which we are considering, in the shape of the Sneezewood fence-posts. Trees of a size to be split into such fence-posts are rareties to-day, but the fact that they existed in that area is shown by the mouldering stumps in the forests, of a size comparable to the giant Yellow-woods, which, because they were hollow or twisted, have been permitted to survive. Such relicts give us the clue that what we call high forest to-day may be little better than the scrub forest of 200 years ago.

22. INVASION OF GRASSVELD BY THORN.

This invasion, occurring mainly in the drainage basin of the White and Black Kei rivers, is rather different, taking place in an area where the climax is the south-eastern variation of the Dry *Cymbopogon-Themeda* veld, and where conditions are too far unsuitable for the Valley Bushveld to permit it to follow the thorns, even when climatic conditions have deteriorated. As has been mentioned (p. 15), *Acacia karroo* is also invading the sourveld of the Transkei along the river valleys, but this invasion is on a small scale.

The spread of *Acacia caffra* up the valleys in Natal, e.g. the Bushmans River valley in the nieghbourhood of Estcourt, is rather the same thing as the spread of *A. karroo* in the Eastern Province Grassveld, pioneering an advance of the Valley Bushveld.

In the Kei basin, the only tree involved is *Acacia karroo*, which usually remains scattered and grows to a good size. Although fresh establishment of thorns occurs at intervals, only in the river valleys and along the foot of the mountains do they become dense enough to shade out the grass and cause soil erosion, by bringing about concentration of grazing pressure on the sweeter and more palatable vegetation that develops under them. Around Tarkastad are some very good demonstrations of the bearing of veld management on thorn tree encroachment—on one side of a fence a hillside will be a dense thicket of thorns, whereas on the other side it will be clear grassveld. The same thing may be seen on the mountain slopes in the Koonap valley north of Adelaide.

Karoo invasion has already penetrated the mountain barrier along the western side of the Black Kei basin, so that a false karroid broken veld is likely to develop here during the next decade or two.

It is perhaps significant that if the average maximum and minimum temperatures for Queenstown are plotted, it will be found that, although the maximum temperature has scarcely risen at all since 1872, when the record starts, the minimum has risen appreciably. If the map of the distribution of *Acacia karroo* is studied, it will be seen that this species avoids only the frostiest parts of the Union.

IV.—KAROO AND KARROID TYPES.

23. The Valley Bushveld.

As the name implies, this veld type is found in the valleys of the numerous rivers, mostly draining into the Indian Ocean. These valleys are hot and receive less rain than the intervening ridges, from 20 to 35 inches per annum. In the case of the Great Fish and Sundays River valleys, which have wide, flat, dry bottoms, the Valley Bushveld proper occurs as narrow belts on the steep, less arid sides of the valleys, particularly on the northern sides.

It can be subdivided as follows:—

(*a*) Valley Bushveld proper, northern variation, extending as far south as the Great Kei Valley;

(*b*) Valley Bushveld proper, southern variation, from the Great Kei to the Kabeljauw's Valley;

(*c*) The Fish River Scrub, in the Lower Great Fish River valley;

(*d*) (i) The Addo Bush and
  (ii) The Sundays River Scrub, in the wide, flat Lower Sunday's River valley;

(*e*) The Gouritz River Scrub.

(*a*) *Northern Variation of the Valley Bushveld.*

[For (*a*) and (*b*) see Marloth II, 2, Pl. 45, Fig. 92; Reynolds, Pl. 22, Fig. 455, Pl. 69; Pl. 51 (right) and Pl. 71 (both Marginal Thornveld); White, Dyer and Sloane, Figs. 1016, 1017, 1021, 1025, 1027, 1037, 1038, 1041.]

This variation is transitional to the Lowveld, particularly from the Umkomaas Valley northwards; indeed, this part should perhaps have been separated as a sixth variation. This northern variation is rather more open than the southern variation, and includes more grass, fewer succulents and more species of definitely tropical nature, e.g. *Euphorbia ingens*, *E. tirucalli*, *Dombeya cymosa*, *Dalbergia obovata*, *Acacia arabica* var. *kraussiana*, *A. robusta*, *Ziziphus mucronata*, *Vitex rehmannii* and *Vangueria infausta*. It is also far less thorny. Fully developed Valley Bushveld is scrub forest dominated by tree *Euphorbias*, but much of it, especially in this northern variation, is scrubforest, with few or no *Euphorbias*, or else dense savannah.

Trees and shrubs of general occurence are:—

Dombeya cymosa	4,308
Euphorbia tirucalli	2,859
Randia rudis	2,616
Jasminum multipartitum	2,551
Dalbergia obovata	1,628
Calpurnia subdecandra	931
Rhus pentheri	911
Asparagus striatus var. zeyheri	771
Ehretia rigida	660
Hippobromus pauciflorus	583
Acacia pennata	471
Plumbago capensis	407
Acacia karroo	374
Acokanthera venenata	365
Capparis citrifoiia	306
Euclea lanceolata	282
Aloe spectabilis	252
Euphorbia triangularis	242
Acacia caffra	213
Gymnosporia buxifolia	210
Ziziphus mucronata	183
Acacia arabica var. kraussiana	114
Cassine aethiopica	84
Brachylaena ilicifolia	78
Grewia occidentalis	78
Rhoicissus cuneifolius	61
Acacia robusta	43
Schotia brachypetala	34
Sarcostemma viminale	33
Ptaeroxylon obliquum	22
Vangueria infausta	22
Cussonia spicata	20
Pappea capensis	19
Senecio brachypodus	16
Buddleja salicifolia	11
Maerua rosmarinoides	7
Fagara capensis	4

Trees and shrubs of less general occurrence include:—

Asparagus falcatus	762
Senecio deltoideus	632
Royena simii	472
Acacia ataxacantha	428
Dichrostachys glomerata	256
Combretum gueinzii	238
Spirostachys africana	222
Gymnosporia polyacantha	185
Dioscorea cotinifolia	181
Bauhinia natalensis	169
Asparagus racemosus	167
Rhoicissus digitatus	145
Acalypha glabrata var. pilosior	111
Jasminum stenolobum	87
Gymnosporia angularis	83
Euclea daphnoides	64
Jasminum angulare	55
Euphorbia pseudo-cactus	49
Abrus laevigatus	42
Helinus integrifolius	33
Canthium spinosum	28
Heteropyxis natalensis	28

and many more.

Smaller plants of general occurrence are:—

Hypoestes verticillaris	51,718
Themeda triandra var.	35,155
Barleria obtusa	25,421
Peristrophe natalensis	15,098
Panicum maximum	5,264
Kalanchoe rotundifolia	2,738
Achyropsis leptostachya	1,776
Eragrostis superba	813
Abutilon sonneratianum	709
Cyperus albostriatus	114

Sporobolus fimbriatus	4,228	Lantana salvifolia	108
Panicum deustum	4,194	Viscum rotundifolium	21
Eragrostis curvula	3,010		

Note the scarcity of succulents and the abundance of Acanthaceae and grasses in the undergrowth. Of less general occurrence are:—

Other Acanthaceae	12,605	Zinnia pauciflora	956
Tragus racemosus	4,297	Cymbopogon plurinoidis	919
Urochloa panicoides	4,064	Cynodon dactylon	808
U. pullulans	3,142	Aizoon glinoides	801
Aristida barbicollis	2,852	Digitaria eriantha var. stolonifera	799
Setaria chevalieri	2,019		
Heteropogon contortus	1,571	Diplachne eleusine	617
Tagetes minuta	1,161	Blepharis natalensis	608
Hyparrhenia sp.	1,103	Hibiscus calyphyllus	484
Cynodon incompletus	997	Chaetacanthus setiger	479
Digitaria longiflora	997	Brachiaria eruciformis	412
		Sporobolus smutsii	351

and many more, the total number of species in the Relative Abundance Table being 585.

(*b*) *Southern Variation of the Valley Bushveld.*

In the southern variation of the Valley Bushveld, the trees and shrubs of general occurrence are:—

Scutia myrtina	3,983	Asparagus medeoloides	152
Capparis citrifolia	3,358	Sarcostemma viminale	142
Rhoicissus digitatus	3,145	Schotia speciosa	125
Azima tetracantha	2,457	Chaetacme aristata	120
Secamone frutescens	2,162	Royena decidua	117
Plumbago capensis	2,008	Pappea capensis	105
Grewia occidentalis	899	Pelargonium peltatum	105
Euclea undulata	840	Olea africana	101
Phyllanthus verrucosus	687	Gymnosporia buxifolia	92
Ptaeroxylon obliquum	653	Schotia brachypetala	88
Gymnosporia capitata	653	S. latifolia	
Euphorbia triangularis	572	Cussonia spicata	60
Cynanchum ellipticum	562	Fagara capensis	56
Asparagus plumosus	536	Sideroxylon inerme	37
Randia rudis	532	Asparagus subulatus	35
Asparagus multiflorus	508	Apodytes dimidiata	27
Allophylus decipiens	487	Jasminum angulare	24
Cassine aethiopica	425	Scolopia zeyheri	15
Portulacaria afra	368	Hippobromus pauciflorus	15
Rhus refracta	357	Harpephyllum caffrum	12
Carissa bispinosa	334	Royena cordata	9
Ehretia rigida	240	Vepris lanceolata	7
Brachylaena ilicifolia	210	Euclea daphnoides	4
Acacia karroo	170	Canthium obovatum	2

Trees and shrubs of less general occurrence include:—

Cassine tetragona var. laxa	822	Rhoicissus cuneifolius	212
Asparagus racemosus	714	Asparagus racemosus var tetragonus	212
Putterlickia pyracantha	487	Rhoicissus cirrhiflorus	211
Gymnosporia undata	362	Rhus longispina	191

Rhoiacarpos capensis....	357	Pleurostylia capensis....	163
Aloe ciliaris............	313	Euphorbia tetragona....	127
Gelonium africanum.....	244	Grewia robusta.........	122
Jatropha capensis.......	237	and many more.	

Note that the commonest species are thorny scramblers. *Euphorbia grandidens* is also of very local importance; while the three tree-Euphorbias (*E. triangularis, E. tetragona* and *E. grandidens*), although they may all occur in one sample, generally do not mix.

Smaller plants of general occurrence are:—

Sansevieria thyrsiflora...	8,726	Moraea iridioides.......	454
Panicum deustum.......	5,848	Croton rivularis.........	405
Viscum rotundifolium...	1,051	Asparagus stipulaceus...	361

Of less general occurence in the undergrowth are:—

Hypoestes verticillaris...	33,023	Cyperus albostriatus....	662
Panicum maximum......	5,946	Pellaea viridis..........	551
Ehrharta erecta.........	5,161	Themeda triandra.......	501
Other Acanthaceae......	3,193	Eragrostis chloromelas..	495
Cyanotis nodiflora.......	1,872	Crassula multicava......	490
Crassula cordata........	1,866	Barleria obtusa.........	450
Plectranthus hirtus......	1,716	Setaria chevalieri........	350
Aptenia cordifolia.......	1,368	Crassula perforata......	324
Sporobolus fimbriatus...	1,082	Asparagus striatus......	319
Cynodon dactylon.......	845	Sida triloba............	318
Setaria neglecta.........	772	Delosperma ecklonis....	313
Heteropogon contortus..	743		

and many more, the total number of species in the Relative Abundance Table being 505.

In this denser bush there is less undergrowth and it includes few of the veld grasses and none in an important role, though the shade grasses are still plentiful.

In both these variations, the bush tends to be scrubbier and reaches a higher altitude on the hotter and drier northern and western aspects, than it does on southern and eastern aspects. On the latter it is regularly tall *Euphorbia* forest, often with *Aloe bainesii*, merging, on the upper slopes, directly into forest, or, where the forest has been destroyed, into grassveld or thornveld. On the upper northern and western aspects there is generally a zone of *Acacia caffra*-thornveld in the northern parts or of bushclump–*Acacia karoo*-thornveld in the southern parts, in both cases with mixed grass. Indeed, if we visualize the country east of the Drakensberg as having been covered with forest and scrub forest, these strips of mixed thornveld along the southern edges of the valleys are almost a necessary postulate to explain the origin of the sour grassveld which has replaced the forest. The bushclumps are, as in the Transvaal bushveld, usually associated with termitaria; and in cases where the bush has been destroyed, we find hummocks in the grassveld strongly resembling the " heuweltjies " of the west coast belt. The flora of the bushclumps includes the less xerophytic species of the Valley Bushveld together with species of the forest margin.

(*c*) *The Fish River Scrub.*

(See Reynonld, Pl. 54, Fig. 462; White, Dyer and Sloane, Figs. 972, 989; Dyer, Figs, 18, 20, 23, 24, 25, 26, 27, 33.)

This veld type occupies the wide, flat valley of the Great Fish River, at elevations ranging from about 300 to 1,500 feet above sea-level; very hot country and receiving a rainfall of only 13 to 20 inches per annum, mainly in the summer months. It is an adaptation of the Valley Bushveld to these exacting conditions. In its undamaged state it is an extremely dense, semi-succulent, thorny scrub, 6–8 feet high; but it has been opened up, overgrazed over large areas, and invaded by the prickly pear and in some parts so heavily by *Euphorbia bothae* that to-day it closely resembles Noorsveld. A similar result of excessive grazing pressure is found in the Tugela Valley, where dense patches of *Euphorbia pesudocactus* are developing, though still on a small scale. Along the escarpment on the north side of the valley, in the narrower lower part of the valley and in the tributary valleys of the Kat and other rivers, there is a fringe of Valley Bushveld; but on the hotter south side there is little development of Valley Bushveld, except in some of the kloofs, the Fish River Scrub becoming less thorny and succulent as one climbs, thinning out into bushclumps and finally merging into the scrubforest of the Grahamstown plateau. At least, that is the climax condition, though its pattern has been obscured by destruction of the scrub-forest and by invasions of Karoo, rhenosterbos and Fynbos. On the floor of the valley, the scrub is being invaded, and in parts replaced by Karoo of Lower Central type, while on the upper slopes, patches of *Pteronia incana* are developing.

In the Fish River scrub, the following are the trees and shrubs of general occurence:—

Portulacaria afra	8,609	Asparagus subulatus	870
Grewia robusta	5,136	Capparis citrifolia	870
Euphorbia bothae	4,727	Rhus refracta	870
Rhoicissus cirrhiflorus	4,227	Euclea undulata	629
Asparagus striatus	3,823	Schotia speciosa	379
Ptaeroxylon obliquum	3,468	Pelargonium peltatum	94
Gymnosporia capitata	3,378	Lycium spp.	89
Azima tetracantha	3,357	Rhus undulata v. genuina	88
Jatropha capensis	3,337	Carissa haematocarpa	67
Phyllanthus verrucosus	2,271	Heeria mucronata	53
Asparagus racemosus var. tetragonus	1,700	Euphorbia pentagona	40
		Gymnosporia undata	37
Pappea capensis	1,691	Grewia occidentalis	36
Senecio vitalis	1,675	Capparis oleoides	18
Brachylaena ilicifolia	1,561	Acacia karroo	14
Crassula argentea	1,271	Euphorbia tetragona	9
Aloe ferox	1,230	Helichrysum sp. = A. 13,735	9
Ehretia rigida	1,160		
Rhigozum obovatum	1,141	Cussonia spicata	6
Sarcostemma viminale	920	Royena cordata	3

Trees and shrubs of less general occurrence include:—

Asparagus racemosus	558	Plumbago capensis	24
Secamone frutescens	278	Putterlickia pyracantha	24
Cadaba juncea	24	Schotia latifolia	24

their fewness (among the commoner species) suggesting that this must be a very uniform veld type.

Species of general occurrence in the undergrowth are:—

Crassula lycopodioides..	6,944	Asparagus stipulaceus...	227
Sanseviera thyrsiflora....	5,012	Limeum aethiopicum....	89
Crassula perforata.......	4,227	Kalanchoe rotundifolia..	53
C. cultrata..............	3,337	Viscum rotundifolium...	39
Cotyledon ramosissima..	1,670	Lasiocorys capensis.....	37
Panicum deustum.......	1,322	Euphorbia mauritanica..	6
Mestoklema tuberosum..	1,227	E. rectirama............	6
Chrysocoma tenuifolia...	1,112	Hermannia gracilis......	6
Crassula tetragona.......	870	Senecio radicans........	6

with the following, and many more, of less general occurrence, the total number of species in the Relative Abundance Table being 215 :—

Acanthaceae (various)...	3,756	Panicum maximum.....	625
Adromischus poellnitzianus	1,111	Pentzia incana..........	625
		Setaria neglecta.........	578
Crassula cordata........	1,111	Crassula lactea.........	561
C. mesembryanthemoides	1,111	Aloe striata............	557
Digitaria argyrograpta...	1,111	Sporobolus fimbriatus...	280
Kedrostis sp............	900	Crassula rupestris.......	278
Sporobolus nitens.......	898		

Succulents and thorny plants, thus, are of great importance in this veld type. It is of interest to note that *Themeda triandra* occurs in this veld, even where on silty and stony slopes down in the valley, the scrub has been broken right down to *Pentzia incana*, *Lasiosiphon meisnerianus*, *Aloe tenuior*, *Becium burchellianum*, *Chrysocoma tenuifolia*, *Pteronia incana*, *Euphorbia mauritanica*, *Drosanthemum lique*, *Hymenocyclus uitenhagensis*, *Ruschia parvifolia*, *Eriocephalus umbellatus*, etc., i.e. False Karoo. It is accompanied by *Cymbopogon plurinodis*, *Digitaria argyrograpta*, *Setaria neglecta*, *Sporobolus nitens*, *Tragus koelerioides*, *Eragrostis obtusa*, *Panicum stapfianum*, *Sporobolus fimbriatus* and *Eragrostis chloromelas*, suggesting that some form of sweet grassveld of similar type to the Eastern Province Grassveld, or grassy shrub-savannah, could, with appropriate management, be established in place of the scrub. At higher levels on the south side of the Fish River valley, where the rainfall is a bit better and the climate not so hot, there is no doubt at all that grassveld and grassy savannah naturally follow the scrub in the reversed succession; traces of it can be seen on the Grahamstown–Bedford road, in spite of a strong Karoo invasion. It has the peculiarity of being invaded by *Danthonia disticha* before the Karoo invades, suggesting an affinity with the Karroid Danthonia Mountain Veld.

The reversed succession down in the valley would appear, therefore, to be:—

(1) Dense, useful succulent scrub with some grass (climax).

(2) Open, useful, succulent scrub with much grass (optimum stage and probably better than artificial pure grassveld).

(3) Open succulent scrub with thorny shrubs and useless succulents invading and/or increasing, and Karoo bushes and Mesembs invading the grassveld constituent (critical stage).

(4) Useless succulent, thorny scrub with weedy Karoo bush and Mesembs and little grass in an eroded, sun-baked, wind-swept wilderness.

(*d*) (i) *Addo Bush.*

(See Marloth III, 1, Fig. 8.)

(ii) *Sundays River Scrub.*

(See Marloth II, 2, Fig. 94; IV, Fig. 23; Reynolds, Pl. 17; White, Dyer and Sloane, Figs, 961. 965.)

These two variations appear to be derived directly from the Alexandria Forest, rather than from the Valley Bushveld. The Fish River valley where the Fish River Scrub occurs, is an inland valley, cut off from the influence of the sea by the Peddie Plateau and the Grahamstown heights, whereas the Sundays River valley lies open to the influence of the sea.

(*d*) (i) Little information has been collected about the fully developed Addo Bush, except that it is a short, dense, dry forest, dominated by such species as *Schotia speciosa*, *S. latifolia*, *Sideroxylon inerme*, *Olea africana*, *Cussonia spicata*, *Cassine aethiopica* and *C. kraussiana*, with abundance of shrubs and climbers, e.g. *Azima tetracantha*, *Portulacaria afra*, *Rhoiacarpos capensis*, *Plumbago capensis*, *Rhus longispina*, *Scutia myrtina*, *Rhoicissus digitatus*, *Sarcostemma viminale* and *Capparis citrifolia*.

(ii) More information, however, is available about the Sundays River Scrub, into which the Addo Bush easily merges. In general appearance it is much like the Fish River scrub, but is less succulent and rather taller. *Euphorbia bothae* of the Fish River Scrub is replaced by *E. ledienii*, and prickly pear is still conspicuous in parts, biological control having been less effective here than further inland. In what little development of Valley Bushveld there is on the sides of the valley, *Euphorbia grandidens* largely replaces *E. tetragona*, *E. triangularis* and *E. curvirama*. Tall *Aloe* spp. are conspicuous in this veld (*Aloe ferox*, *A. speciosa*, *A. africana*, *A. pluridens*, *A. lineata*). Elevation ranges from 0 to over 1,500 feet above sea-level and rainfall from 10–20 inches per annum, spread over the year.

Trees, shrubs and climbers of general occurrence are:—

Rhoicussus cirrhiflorus	7,669	Senecio longifolius	735
Capparis citrifolia	4,484	Sideroxylon inerme	643
Euclea undulata	4,418	Pappea capensis	621
Rhus longispina	4,250	Lycium spp	455
Schotia speciosa	4,230	Crassula argentea	185
Azima tetracantha	3,311	Asparagus subulatus	139
Asparagus racemosus	2,894	Viscum rotundifolium	134
Pelargonium peltatum	2,666	Ehretia rigida	72
Carissa bispinosa	2,597	Aloe speciosa	68
Sarcostemma viminale	2,325	Cassine aethiopica	29
Euphorbia ledienii	2,188	Asparagus multiflorus	28
Putterlickia pyracantha	1,738	Rhus refracta	23
Gymnosporia capitata	1,302	Gymnosporia buxifolia	21
Portulacaria afra	1,207	Maerua triphylla	14
Grewia robusta	1,015	Ptaeroxylon obliquum	11
Scutia myrtina	1,015	Opuntia maxima	9
Gymnosporia polyacantha	910	Capparis oleoides	2
Rhoicissus digitatus	861	Cussonia spicata	2
Plumbago capensis	856	Acacia karroo	0·3
Aloe ferox	855		

Trees, shrubs and climbers of less general occurrence include:—

Cassine tetragona var. laxa	557
Asparagus racemosus var. tetragonus	425
Lycium campanulatum..	361
Cynanchum ellipticum...	350
Euphorbia pentagona....	301
Grewia occidentalis......	283
Asparagus medeoloides..	281
Cadaba juncea..........	225
Senecio pyramidatus....	139
Brachylaena ilicifolia....	92
Asparagus falcatus......	69
A. plumosus...........	69
Phyllanthus verrucosus..	69

and many more.

In the undergrowth, the following are of general occurrence:—

Sanseviera thyrsiflora....	14,340
Crassula perforata.......	6,752
Panicum deustum.......	4,574
Senecio radicans........	4,437
Crassula cultrata........	2,755
Asparagus stipulaceus....	1,284
Fockea sp.............	981
Crassula acutifolia.......	877
Eragrostis obtusa........	689
Selago triquetra.........	566
Setaria nigrirostris.......	510
Crassula mesembryanthemoides	420
Hermannia candicans...	122
Euphorbia rectirama....	109
E. mauritanica..........	86
Crassula lycopodioides..	85
Kedrostis sp...........	81
Asparagus kraussii......	75
Cotyledon orbiculata....	71
Helichrysum sp. cf. H. rosum	64
Crassula spathulata.....	21

with the following of less general occurrence:—

Plectranthus hirtus......	20,012
Hypoestes verticillaris...	6,400
" Mesem " spp.........	6,347
Tritonia securigera......	3,490
Delosperma ecklonis.....	1,736
Gasteria spp............	1,417
Oxalis semiloba	1,209
Cynodon incompletus...	1,111
Hypoxis sp. = A. 13640.	1,031
Trochomeria sp.........	939
Crassula sp.............	800
Justicia capensis........	793
Digitaria argyrograpta..	639
Stipa dregeana var. elongata	550
Other Acanthaceae......	400
Dicliptera capensis......	400
Asparagus striatus......	365
Panicum maximum.....	329
Aster muricatus.........	311
Crassula expansa.......	306
Zygophyllum debile.....	211

and many more, the total number of species in the Relative Abundance Table being 307.

Here succulents total 36,162 as compared with 36,921 in the Fish River Scrub.

Here thorny plants total 23,757 as compared with 19,753 in the Fish River Scrub.

Here climbers total 27,476 as compared with 12,937 in the Fish River Scrub.

So the Sundays River Scrub is just as succulent as the Fish River Scrub (except that the succulents are mostly smaller), and even more thorny and tangled. Near the mouth of the Sundays and Swartkops rivers, the scrub is very stunted, including such species as *Lycium afrum*, *Zygophyllum morgsana*, *Senecio longifolius*, *Suaeda fruticosa*, *Lasiocorys capensis*, *Drosanthemum fourcadei* and clumps of normal bush and tends to be replaced by Succulent Karoo on heavy soil, by stunted Fynbos on sand and limestone, rather than by the Pentzia-dominated False Central Lower Karoo which invades in the more inland parts.

(*e*) *The Gouritz River Scrub.*

(See King, Fig. 296.)

This variation occurs in the valleys of the Gouritz, Little Brak and Great Brak rivers, with traces only occurring in the valleys westwards. It is closely related to the Sundays River scrub, except that the big scrubby and arborescent *Euphorbia* spp. are replaced entirely by tall *Aloe* spp. (*A. ferox*, *A. speciosa*, *A. arborescens*), the only *Euphorbias* seen being the smaller *E. burmannii*, *E. mauritanica*, and *E. clava*; and *Portulacaria afra* is absent. Like most of the Sundays River Scrub, it merges upwards into Fynbos and Rhenosterbosveld, and there is a well marked aspect difference, the scrub of the southern aspects being non-succulent and non-thorny, but very dense, comparable with that of southern aspects in the Spekboomveld and the Karroid Broken Veld, but with a larger element of Fynbos in it. This veld type may become replaced by groves of *Aloe ferox*, e.g. below Herbertsdale and around Riversdale.

24. NOORSVELD.

[See Marloth II, 2, Fig. 91; Reynolds, Pl. 66, Fig. 511; White, Dyer and Sloane, Fig. 713 (Pappea-veld), Figs. 949, 950, 952, 953, 955, 957, 960.]

This veld type rather resembles those tramped out parts of the Fish River Scrub where *Euphorbia bothae* has become dominant. It is a uniform, 4–6 foot high scrub of grey, shrubby *Euphorbia caerulescens* (Noors), dotted with small trees. It occupies the wide, undulating middle part of the Sundays River valley, north of the Grootriver Heights and Zuurberg, and centred on Jansenville. Up the northern slopes of these mountains and up the slopes of hills to the north, it merges into Spekboomveld, while on the plains to the west and east, and north of the hills, it peters out, via open *Pappea* veld, into open Karroid Broken Veld. Outliers occur on the lower northern slopes of the Great Winterhoek mountains. Elevation ranges from 1000–2,000 feet above sea-level and rainfall is about 10 inches per annum, mostly a little less.

Euphorbia caerulescens is overwhelmingly dominant, along with:—

Rhigozum obovatum.
Grewia robusta.
Gymnosporia polyacantha.
Euclea undulata.
Capparis oleoides.
Pappea capensis.
Gymnosporia capitata.
Nymania capensis.
Schotia speciosa.
Lycium austrinum.
Carissa haematocarpa.
Rhus undulata var. genuina.
Aloe ferox.
Portulacaria afra

but, apart from the taller, dark green *Pappea*, *Schotia*, *Capparis* and *Lycium*, these shrubs are inconspicuous.

Owing to the ability of goats to eat chopped *Euphorbia caerulescens*, as a last resort in drought, this veld type has suffered particularly badly from overgrazing, and in its present condition is often seen dimly through a sand storm. The eroded stony spaces between the shrubs, therefore, are usually bare, apart from a little *Pentzia incana* (ankerkarroo), *Eriocephalus ericoides*, *Euphorbia ferox*, *Selago triquetra*, *Indigofera patens*, *Mestoklema tuberosum*, *Eragrostis obtusa*, *Phymaspermum pubescens* and others, and sometimes annuals, notably *Psilocaulon absimile*. Nevertheless, in the shelter of the shrubs one can still find such grasses as *Setaria neglecta*, *Aristida diffusa* var. *burkei*, *Digitaria argyrograpta*, *Themeda triandra*, *Heteropogon contortus*, *Eragrostis lehmanniana*, *E. curvula*, *Cenchrus ciliaris*, *Panicum maximum*, *Sporobolus fimbriatus*, *Enneapogon scoparius* and *Ehrharta calycina*, suggesting that even in this dry region, the Karoo is an invader. Certainly it supports the view that these karroid bushveld types are related to the Karoo only to the extent that certain of the shrubs belonging to them occur in the Great Karoo and Little Karoo, i.e. these Karoo types can rather be said to have a bushveld affinity than the succulent bushveld types can be said to have a Karoo affinity. It would thus be better to use the term Succulent Bushveld in place of Karroid Bushveld.

25. Succulent Mountain Scrub or Spekboomveld.

This is essentially a veld type of steep, sandstone, quartzite and shale mountain slopes in the east and southern Cape, which receive 9–12 inches of rain per annum. It is typically a dense scrub dominated by *Portulacaria afra* (spekboom), with more or less of the shrubs of the other succulent bushveld types, but lacking the tangled thorniness of those types; the admixture of other species becomes less and less westwards, until towards its western limits, it is almost a pure stand of *Portulacaria*, e.g. on the red precipices of Huis River Pass. On steep southern aspects, *Portulacaria* is often rare or even absent and the vegetation is a more or less non-succulent scrub or even scrub-forest; on a small scale map it cannot be shown separately.

Along the Baviaanskloof, the presence of *Euphorbia grandidens* both in the Spekboomveld and the non-succulent scrub of the southern aspect, suggests a derivation from the Valley Bushveld; and it merges easily into the Valley Bushveld in the eastern part of its habitat, e.g. in the Great Fish River valley between Cookhouse and Cradock, where, however, most of both these types has been reduced to False Karroid Broken Veld.

Besides *Portulacaria afra*, important trees and shrubs include:—

Crassula argentea.
Lycium austrinum.
Pappea capensis.
Euclea undulata.
Rhigozum obovatum.
Grewia robusta.
Putterlickia pyracantha.
Gymnosporia zeyheri.
Rhoicissus cirrhiflorus.
Nymania capensis.
Aloe speciosa.
Rhus longispina.
Schotia speciosa.
S. latifolia.
Rhus lucida.
Tarchonanthus minor *l.*
Dodonaea thunbergiana *l.*
Buddleja lobulata.
Polygala myrtifolia *l.*
Carissa haematocarpa.

while among the smaller plants are:—

Crassula perforata.
C. rupestris.
C. cultrata.
C. tetragona.
C. lycopodioides.
C. rogersii.
C. obvallata.
C. perfoliata.
Euphorbia mauritanica.
Digitaria glauca.
Delosperma frutescens.
Cotyledon ramosissima.
C. orbiculata.
Ruschia spp.
Senecio junceus.
Sansevieria thyrsiflora.
Panicum maximum.
Cyphia sylvatica.
Adromischus poellnitzianus.

In the southern part of its habitat it regularly gives way rather suddenly upwards to an open, grassy, false macchia, with such species as:—

Passerina obtusifolia.
Polygala myrtifolia.
Selago albida.
Royena decidua.
Lasiosiphon meisnerianus.
Aloe ferox.

Elytropappus rhinocerotis.
Aster filifolius.
Eriocephalus umbellatus.
E. capitellatus.
Chrysocoma tenuifolia.
Pteronia incana.
Rhus incisa.
Indigofera stenophylla.
Royena cordata.
A. comptonii.
Montinia caryophyllacea.
Anthospermum tricostatum.
Agathosma ovata.
Aspalathus spp.
Ruschia spp.
Encephalartos lehmannii.
Euphorbia rectirama.
Machairophyllum acuminatum.

with the following grasses:—

Themeda triandra.
Sporobolus fimbriatus.
Setaria lindebergiana.
Ehrharta calycina.
Danthonia disticha.
D. stricta.
Pentaschistis spp.
Melica racemosa.
Eragrostis curvula.
E. chloromelas.
Aristida diffusa var. burkei.
Heteropogon contortus.
Rhynchelytrum repens.

In the north-eastern part of its habitat, where it fringes Bruintjieshoogte, the Tandjiesberge and the mountains around Graaff-Reinet, it merges upwards into the Grassy Mountain Scrub variation of the Karroid Broken Veld (in which *Rhus lucida* is dominant) and so into the Karroid Danthonia Mountain veld or into False Karoo. In the Jansenville area, and in some of the valleys of the Grootrivier Heights, it merges downwards gradually into Noorsveld; elsewhere it breaks off rather suddenly at the edge of the Karroïd Broken Veld and Succulent Karoo.

The scrub of steep south aspects is rather related to the False Fynbos above the Spekboomveld, but taller and denser, ranging from semi-succulent Rhenosterbosveld plus *Dodonaea thunbergiana*, *Rhus lucida* and *Euclea undulata*, up to complete scrub-forest like the upper margin of the Valley Bushveld. Succulents are not entirely absent, but, although arborescent *Aloe* spp. may be conspicuous, they are never dominant.

This veld type has suffered much damage from overgrazing and from invasion by prickly pear; and it is probable that it has been entirely destroyed over long stretches of mountainside. The differential effects of grazing treatment are very clearly seen on the Wolvefonteinberg.

26. KARROID BROKEN VELD.

This is the veld of the Great Karoo, the Little Karoo and the Robertson Karoo. It is Karoo veld dotted with dwarf trees and shrubs, and including varying amounts of grass and succulents. Three main variations can be distinguished:—

(*a*) *The Great Karoo*, in which succulents are usually relatively scarce, but grass species are surprisingly numerous, though usually rare as regards number of individual plants. Shrubs are scarce too. This variation occupies undulating stony plains, receiving a rainfall ranging from under five inches to about eight inches per annum, mostly in autumn; elevation above the sea ranges from 1,500–3,500 feet.

(*b*) *The Little Karoo* (including the Robertson Karoo), in which succulents are dominant and the dwarf trees and shrubs are numerous; grasses, on the other hand, are scarce. This occupies rocky, hilly country, at elevations ranging from 1,000–2,000 feet above the sea, and receiving 6–12 inches of rain per annum, distributed, on the average through the year; the climate is hot. The permanent scarcity of rain will partly explain the prevalence of succulents, while the low altitude and the better soil-water relations produced by the rocky hilliness will explain the shrubbiness. Thus it can be noticed that the flatter parts of the Little Karoo, e.g. in Oudtshoorn Division, have less shrubbiness, and the few rocky parts of the Great Karoo, e.g. south of Beaufort West, have more shrubbiness than average. A fringe of this variation separates the southern margin of the Great Karoo from the Spekboomveld and False Fynbos of the Swartberg and other mountains as far east as Willowmore.

(*c*) *The Grassy Mountain Scrub*, through which the Karroid Broken Veld passes into the grassveld and Fynbos of the mountains.

(*a*) *The Great Karoo..*

(See Cannon, Pl. 6A and B, 7A, 8; Hutchinson, p. 60, facing p. 192; King, Figs. 91, 169.)

These stony plains are so completely denuded of soil that it is difficult to imagine them in any other condition. Here and there, however, one finds indications, e.g. patches of silt high on either side of a stony valley, that it was not always so, so that the country in which the Bushmen lived and which the first Trekkers saw, was not the wilderness that it is to-day, arid though it may have been. The idea that the Great Karoo is naturally what is is to-day receives a bad jolt when one finds a grass like *Heteropogon* in the heart of the Koup, where the rainfall to-day is only six inches per annum; or *Themeda* at the foot of the Nieuwveld escarpment, where the rainfall is only eight inches; and sees what a transformation a few years of rest, e.g. along the National Road between Prince Albert Road and Beaufort West, or a few years of careful management, e.g. on Mr. Mocke's farm Vindragersfontein near Merweville, can bring about. If the rocky parts can still support such grasses, what was the vegetation of the riverine vleis when they were real vleis, vegetated and capable of controlling and using the water which came down from the mountains, instead of being the stony, over-efficient drains that they are to-day?

The vegetation to-day is sparse Karoo veld with stunted shrubs, especially in rocky (as distinct from stony) places, and thornveld along the rivers. In the drier western part where the Great Karoo veld merges into that of the Little Karoo, *Tamarix austro-africanae* also becomes important along the rivers.

The principal karoo bushes are:—

Pentzia spinescens.
Eriocephalus spinescens.
Galenia fruticosa.
Zygophyllum microphyllum.
Pteronia glomerata.
P. adenocarpa.
Drosanthemum framesii.
D. lique.
Hermannia cuneifolia.
Eriocephalus pubescens.
E. ericoides.
Garuleum bipinnatum.
Osteospermum sinuatum.
Pentzia incana (ankerkaro).
P. globosa.
Monechma pseudopatulum.
Delosperma subincanum.
Asparagus sp.
Lebeckia spinescens w.
Salsola rabieana.
Trichodiadema barbatum t.
Barleria rigida.
Helichrysum lucilioides.
Lasiosiphon meisnerianus.
Dicoma spinosa.
Microloma massonii.
Euphorbia arida.
Chrysocoma tenuifolia.
Hermannia grandiflora.
Polygala seminuda.

Aster filifolius.
Sericocoma avolans.
Hermannia spinosa.
Sarcocaulon patersonii.
Limeum aethiopicum.
Trianthema parvifolia.
Euphorbia stellaespina and many other spp., especially eastwards.
Hermannia linifolia.
Tetragonia fruticosa.

The principal shrubs and trees are:—

Acacia karroo W.
Rhus lancea W.
Tamarix austro-africana W^{W}.
Royena pallens W.
Nicotiana glauca W.
Salsola aphylla W.
S. sp. prob. S. geminiflora W.
Suaeda fruticosa W.
Zygophyllum microcarpum W.
Rhigozum obovatum.
Carissa haematocarpa.
Rhus undulata var. burchellii.
Gymnosporia polyacantha.
G. integrifolia.
Lycium arenicolum.
L. austrinum.
Thesium lineatum.
Asclepias filiformis.
Euclea undulata W.

The principal perennial grasses are:—

Aristida obtusa.
Enneapogon scaber.
E. brachystachyus.
Lepturella capensis.
Eragrostis obtusa.
E. margaritacea W, h.
E. bicolor h.
Aristida diffusa var. burkei.
A. ciliata.
Digitaria argyrograpta.
Fingerhuthia africana.
Cenchrus ciliaris tw.
Tragus koelerioides.
Aristida namaquensis W.
Sporobolus usitatus W.
Heteropogon contortus.
Themeda triandra.
Eragrostis lehmanniana.
Digitaria eriantha.
Sporobolus fimbriatus.
Stipa namaquensis.
Aristida uniplumis.

The annuals (including grasses) and geophytes include:—

Aristida curvata.
A. congesta.
Augea capensis.
Mesembryanthemum spp.
Cuspidia araneosa.
Euphorbia inaequilatera.
Moraea polystachya.
Gazania lichtensteinii.
Galenia sarcophylla.
Tribulus terrestris.
Tragus racemosus.
Schizobasis intricata.
Hypertelis verrucosa.
Eragrostis porosa.
Amaranthus angustifolius.
Psilocaulon absimile.
Brownanthus ciliatus.
Allenia urens.
Ornithoglossum viride.
Enneapogon cenchroides.
Ursinia nana.
Eragrostis procumbens.
Aridaria tetragona.
Mollugo cerviana.
Sutera tristis.
Eragrostis sp. = A. 14,327.

and many more; a rich flora in spite of the sparseness of the vegetation to-day. The phenomenon of " dry rain " in these parts has already been discussed.

In the gap in the escarpment between the Nieuwveld Mountains and the Camdeboo mountains, the Great Karoo extends up the valleys and, in scrubby form, up the slopes of the isolated mountains. Here the Great Karoo (and the Central Lower Karoo) merge directly into the Central Upper Karoo.

(*b*) *The Little Karoo.*

[See Marloth I, Fig 84A; II, 1, Pl. 6; III, 1, Pl. 11; III, 2, Fig. 80, Pl. 68; IV, Fig. 45; Cannon, Pl. 12, 15, 16, 17, 18B, 21; Reynolds, Pl. 45 (outlier); Hutchinson, facing pp. 64, 65; White, Dyer and Sloane, Figs. 399, 709; King, Figs. 85, 292, 295; Adamson, Photo 17.]

This is distinguished from the Great Karoo only by the greater number of shrubs and succulents occurring in it, and there is no clear cut boundary between the two in the western part of their area, the Little Karoo veld around Laingsburg merging gradually into the Great Karoo veld. Similarly, both variations of the Karroid Broken Veld merge easily into the Succulent Karoo, when the succulents increase to the point of dominance and the shrubs thin out to nil.

Justice cannot at this stage be done to the Little Karoo flora, because only those species of Mesembryanthemum (in the wide sense) can be mentioned, which the writer has succeeded not only in finding in flower, but in delivering to Dr. L. Bolus before the flowers faded. Many of the Mesems are even more difficult to distinguish in the vegetative condition than they are when flowering, particularly those bushy ones that are important constituents of the vegetation, so that the listing method cannot yet be adequately applied to such veld types as the Little Karoo and the Succulent Karoo. Although the Mesems are so important to-day, the fact that few of them are eaten by livestock and the fact that non-succulent karoo-bushes are still quite common, but always eaten down into woody stumps, suggests that the *dominance* of the Mesems is an artificial phenomenon, resulting from selective overgrazing and soil erosion.

The typical shrub (or dwarf tree) is *Euclea undulata*; its principal associates are:—

Cotyledon paniculata.
Carissa haematocarpa.
Lycium austrinum.
L. arenicolum.
Rhigozum obovatum.
Rhus undulata var. genuina.
Putterlickia pyracantha.
Cadaba juncea.
Microdon cylindricus.
Pappea capensis.
Schotia speciosa.
Asparagus racemosus.
Zygophyllum foetidum.
Pelargonium peltatum.
Euphorbia mauritanica.
E. burmannii.
Thesium lineatum.
Nymania capensis.

The Karoo bushes include:—

Eriocephalus ericoides.
Pentzia incana (ankerkaro).
Hirpicium integrifolium.
H. alienatum.
Nestlera humilis.
Galenia africana.
Crassula argentea.
C. rupestris.
C. subsessilis.
Tetragonia fruticosa.
Blepharis capensis.
Helichrysum zeyheri.
Pelargonium ramosissimum.
P. squarrosum and others.
Pteronia flexicaulis.
Salsola zeyheri.
Euphorbia mundii.
E. rectirama.
E. stolonifera.
Hermannia linifolia.
Asparagus burchellii.
Garuleum bipinnatum.
Cotyledon reticulata.
Aster muricatus.
Galenia fruticosa.
Osteospermum microphyllum.
Adromischus sphenophyllus.
Apicra foliosa.
A. deltoidea.
A. rubriflora.

Sarcocaulon burmannii.
Osteospermum sinuatum.
Pachypodium succulentum.
Cotyledon decussata.
Sericocoma avolans..
S. pungens.
Monechma pseudopatulum.
Dicoma spinosa.

and many more.

Of the Mesems, we can only name a few; this list does not claim to include even all of the common species. Many of them are very local in their distribution, e.g. only on patches of quartz gravel, or only in rock crevices on the hilltops:—

Aridaria blanda.
A. vigilans.
A. defoliata.
A. noctiflora.
Brownanthus ciliatus.
Cephalophyllum curtophyllum.
C. vandermerwei.
Cerochlamys pachyphylla.
Conophytum petraeum.
Delosperma pageanum.
D. subincanum.
Gibbaeum shandii.
G. perviride.
G. pubescens.
Glottiphyllum fragrans.
Hereroa latipetala.
H. stanleyi.
H. odorata.
Hymenocyclus spp.
Lampranthus haworthii.
L. henricii.
L. uniflorus.
Leipoldtia spp.
Mesembryanthemum karrooënse.
Psilocaulon utile.
P. absimile.
P. simile.
Rhinephyllum macradenium.
R. luteum.
Ruschia multiflora.
R. caroli.
R. ferox.
R. stellata.
R. aculeata.
R. montaguensis.
R. laxipetala.
R. fourcadei.
Sceletium spp.
Trichodiadema barbatum.
Drosanthemum hispidum.
D. delicatulum.
D. lique.
D. speciosum.
D. bredai.

and many more.

Grasses are inconspicuous in this veld type, though where the veld is rested for some years, they begin to reappear, e.g. along the National Road near Laingsburg:—

Cladoraphis spinosa W.
Aristida namaquensis W.
A. brevifolia w.
A. ciliata.
A. obtusa.
A. congesta.
Enneapogon brachystachyus.
E. scaber.
Ehrharta calycina.
Hyparrhenia hirta.

As has been said, the Little Karoo is rocky and hilly, odd looking country in the western part, where it is a maze of evensized, brown, stony little hills. This type of topography increases the effect of the rainfall by concentrating run-off from the rocks into pockets of soil and it provides a variety of habitats, inducing a varied flora. On the higher hills and ridges, *Elytropappus rhinocerotis* is regularly present, and round the margins of the Little Karoo becomes important in the transitions to Mountain Rhenosterbosveld and Fynbos. It is accompanied, in the Little Karoo, by such species as:—

Cotyledon paniculata.
C. wallichii.
Rhus lucida.
Euphorbia mauritanica.
E. burmannii.
Euryops tenuissimus.

R. rosmarinifolia.
Euclea undulata.
E. tomentosa.
Pteronia fasciculata.
P. flexicaulis.
P. paniculata.
P. pallens.
P. incana.
Relhania squarrosa.
R. genistifolia.
Galenia africana.
E. lateriflorus.
E. imbricatus.
Polygala pinifolia.
Zygophyllum flexuosum.
Dodonaea thunbergiana.
Berkheya fruticosa.
Ruschia multiflora.
R. cymosa and other shrubby spp.
Ehrharta calycina.
Lebeckia cytisoides.

forming the two to six foot scrub which is so characteristic of the less arid Little Karoo hillsides. Outliers of it occur as narrow belts and patches on the slopes of the Klein Roggeveld mountains and of the Roggeveld escarpment (included in the Western Mountain Karoo on the map); in the Olifants River valley south of Clanwilliam; on the slopes of the Piquetberg and Olifants River mountains and in the Doorn River valley north-east of Clanwilliam, linking the Karroid Broken Veld of eastern origin, with the Namaqualand Broken Veld of north-western and central origin. This applies to the usually shaly mountain slopes and ridges, but on sandstone there is a transition direct to Arid Fynbos; this geological differentiation is well seen in the Doorn River valley below Pakhuis Pass, where the Little Karoo scrub on shale may occur above the Arid Fynbos on sandstone.

Round the margins of the Little Karoo, especially in the Robertson Karoo, the bush is often quite dense and tends to develop into clumps, the botanical composition of which leaves no doubt about the relationship of this veld to the Succulent Bushveld. These bush clumps occupy low mounds, but, so far as has been noticed, they are not associated with termitaria, appearing rather to start as clumps of *Euphorbia mauritanica*, which, by its relatively tall growth and denseness right down to ground level, catches and holds wind-blown soil, so building up a mound.

On dry plains at higher levels, e.g. around Touws River, we find a transition to Mountain Rhenosterbosveld and even Western Mountain Karoo, via a semi-succulent, open karroid rhenosterbosveld.

The thornveld along the rivers is particularly well developed, sometimes almost a forest of tall *Acacia karroo*, with *Rhus lancea*, *Salix capensis*, *Rhus pyroides*, *Buddleja salicifolia*, *Freylinia oppositifolia*, *Phragmites communis*, *Royena pallens*, *Nicotiana glauca* and the climbers, *Clematis* sp., *Zygophyllum foetidum* and *Asparagus* spp.

(*c*) *Mountain Scrub.*

(See Marloth, II, 2, Pl. 78.)

In the Little Karoo, up the sides of the mountains, this semi-succulent scrub becomes non-succulent, with *Dodonaea thunbergiana*, *Acacia karroo*, and *Rhus lucida* in Rhenosterbosveld. At the margin of the Great Karoo, however, we find a different type of scrub, also largely non-succulent, but very grassy. It is related to the non-succulent scrub associated with the Spekboomveld, but extends beyond the limits of that veld type into the wetter and cooler regions along the mountains from the Boschberg and Bankberg to the Camdebooberg and Sneeuwberg, and again on the eastern part of the Nieuwveld Range. In these parts it is transitional, not to Mountain Rhenosterveld and Fynbos, but to Karroid Danthonia Mountain Veld and is very grassy. On southern aspects it is a dense, grassy scrub, on northern aspects it is a grassveld dotted with shrubs, usually, in varying degrees, invaded by Karoo and rhenosterbos. The shrubs of the normal Karroid Broken Veld nearly all occur, but there are important additions, e.g.:—

Olea africana.
Grewia occidentalis.
Myrsine africana.
Kiggelaria africana.
Celtis kraussiana.
Tarchonanthus minor.
Rhus lucida.
R. erosa (north-eastwards).
Dodonaea thunbergiana.
Cussonia paniculata.
Osyris compressa.
Gymnosporia zeyheri.
Aloe ferox (sometimes).
Rhamnus prinoides.
Buddleja lobulata.
Pittosporum viridiflorum.

The dominant grass is *Aristida diffusa* var. *burkei*, associated with the following species:—

Eragrostis chloromelas.
Sporobolus fimbriatus.
Heteropogon contortus.
Eustachys paspaloides.
Setaria neglecta.
Cymbopogon plurinodis.
Fingerhuthia africana.
Enneapogon scoparius.
Themeda triandra.
Danthonia disticha L.
Ehrharta calycina.
and others.

27. CENTRAL UPPER KAROO.

(See Marloth, III, 2, Pl. 62.)

This is a well marked veld type occupying the central part of the upper plateau south of the Orange River, at altitudes ranging from 3,500–5,500 feet above the sea, and receiving 7–10 inches of rain per annum, the rainy season being in late summer. It is flat country dotted with dolerite hills and ranges of hills and mountains, especially south-westwards. In general the plains are stony (shale, sandstone and calcareous tufa), though sometimes covered with shallow red, sandy loam, and there are wide, silty flats or flood plains along the rivers.

The hills and mountains are more grassy than the plains, but there is not the great difference that there is in the False Karoo. The tops of the higher mountains are Karroid Danthonia Mountain Veld. The vegetation is a fairly grassy Karoo (the grasses being of the " white " type and represented to-day mainly by *Eragrostis lehmanniana* and *Aristida congesta*), with bigger shrubs (*Lycium* spp. *Rhigozum trichotomum*) mainly on the flood plains of the rivers and on and around the hills. The characteristic shrub of the hills themselves is *Rhus undulata* var. *burchellii*. On the plains, the flora is regularly richer in the stony parts than elsewhere, while the occasional patches of loose sand amongst the hills carry an *Aristida diffusa* var. *burkei–Eriocephalus ericoides* veld rather of Kalahari Thornveld type. The flood plains sometimes retain a very dense, grassy, short Karoo. The only succulent of general importance is *Ruschia ferox*, but a number of Mesems and other succulents are regularly present as rareties.

The whole of this veld type is to some degree invaded by elements of the Arid Karoo and sheet eroded. Typical species (excluding grasses) include:—

Eriocephalus ericoides.
E. spinescens.
E. pubescens.
S. nigrescens *l.*
S. rabieana.
Aster barbatus.

Pentzia globosa.
P. spinescens.
P. virgata (on limestone).
P. lanata.
P. incana (ankerkaro).
P. sphaerocephala.
Plinthus karrooicus.
Nenax microphylla.
Pteronia glauca.
P. erythrochaeta W.
P. glaucescens W.
P. glomerata.
Nestlera humilis.
N. conferta.
N. prostrata.
Rosenia glandulosa.
Pegolettia retrofracta.
Aster muricatus.
Chrysocoma tenuifolia.
Tetragonia arbuscula.
Kochia pubescens W.
Suaeda fruticosa W.
Lycium prunus-spinosa W.
L. arenicolum W.
Phymaspermum aciculare.
Salsola glabrescens W.
Thesium hystrix.
Limeum aethiopicum.
Arthrosolen polycephalus.
Moraea polystachya.
Homeria pura.
Geigeria passerinoides.
Osterospermum spinescens W.
O. leptolobum.
Helichrysum lucilioides.
Hermannia multiflora.
Microloma massonii.
Sutera pinnatifida.
S. atropurpurea.
S. halimifolia.
Lightfootia tenella.
Drosanthemum lique t.
Aster filifolius.
Osteospermum scariosum.
Sceletium sp.
Rhus undulata var. burchellii.
Helichrysum pentzioides W.
Othonna pavonia W.
Asparagus stipulaceus.
Euphorbia aequoris.
Lessertia pauciflora.

Geigeria passerinoides formerly caused losses of stock in this region, but to-day it is quite a rare plant, occurring in depressions, *where it receives a little extra water*; another indication of climatic deterioration.

The short, dense veld of the flood-plains takes two forms: (i) dense, short grassveld; (ii) dense, short karoo.

(i) The grasses are mainly *Eragrostis bicolor*, *Sporobolus usitatus*, and *S. acinifolius*, with more or less *Panicum stapfianum*, and, in higher parts, *Eragrostis bergiana*. It can be surprising and instructive, when travelling along a dry road through a dry countryside, to come upon one of these grassy vleis with a layer of more or less clear water trickling through it, coming down from some place that had a good storm the previous day. Had there been a donga instead of a grassy vlei, the water would have been gone in an hour or two, and it would not have done anything more useful than freshen up a few *Lycium* bushes.

(ii) The principal species are:—

Pentzia incana (ankerkaro).
Aster muricatus.
Salsola nigrescens.
S. tuberculata (sometimes).
Nestlera humilis.
N. conferta.
Gazania longifolia.
Pentzia spinescens.
P. lanata.
Lycium oxycladum.
Pteronia erythrochaeta.
P. sordida.
P. glomerata.
Plinthus karrooicus.
Arthrosolen polycephalus (sometimes).
Asparagus sp. (stiff, glaucous, spiny).
Ruschia vulnerans.
R. uncinella.

Walafrida geniculata.
Eragrostis bergiana.
Sporobolus usitatus.
Zygophyllum microphyllum.
Aster sp. = A. 12,598.
A. barbatus.
Aridaria sp. §. Noctiflora.
Geigeria passerinoides.

and many more.

There is a strong resemblance between this veld and the corresponding veld of the Central Lower Karoo. The interesting thing is that little patches of this dense, well-mixed Karoo will occur in what is otherwise a " vloer ", giving us another clear indication of what the former grazing value of the veld was.

The grasses of the Central Upper Karoo include:—

Eragrostis lehmanniana.
E. obtusa.
E. bergiana.
E. bicolor W.
E. denudata.
E. curvula.
Aristida diffusa var. burkei.
A. barbicollis.
A. congesta.
A. curvata.
A. obtusa.
A. ciliata.
Setaria verticillata k.
A. namaquensis W.
Enneapogon brachystachyus.
Digitaria argyrograpta.
Fingerhuthia africana.
F. sesleriaeformis W.
Agrostis lachnantha W.
Lepturella capensis.
Sporobolus fimbriatus.
S. usitatus. W.
S. ludwigii W.
Schismus fasciculatus.
Phragmites communis W.

The response of *Phragmites* along the rivers to a few years rest from grazing is remarkable.

Little information is available as yet about the flora of the mountains.

28. The Western Mountain Karoo.

This veld type occupies very stony country, mostly shale, fine grained sandstone and granite, with a topography ranging from gently undulating to steeply rolling. Rocky outcrops are few; here occurs a transition to Little Karoo on the one hand and to Namaqualand Broken Veld on the other. Soil is conspicuous by its absence, except in some of the valleys and flatter parts; but it must be remembered that this region is amongst the oldest settled in the Cape Province, so that erosion has had ample opportunity to remove the last patch of erodible soil. The resulting absence of visible erosion gives one in this veld type, a pleasing impression of stability, even though one realizes that it is at a lower level of productivity than it was when the Bushmen were raiding the early European settlers' flocks and herds 180 years and more ago.

It has two variations: (*a*) The upper, or typical form is a tall, almost non-succulent Karoo. It merges into the Central Upper Karoo in the neighbourhood of Fraserburg, from there stretching westwards along the gentle northern slopes of the Roggeveld mountains, and northwards along the Hantamsberg to the Loeriesfontein area and thence in patches on the higher mountains through Namaqualand. This is the wetter and cooler form, at elevations of 3,000–5,500 feet above the sea, and receiving 5–10 inches of rain per annum. It borders on the winter rainfall area eastwards, extending into it north-westwards. Upwards it merges into the Mountain Rhenosterveld, or into the non-succulent variation of Namaqualand Broken Veld; (*b*) The lower, or semi-succulent form. At lower elevations and in drier country, along the south-western foot of the Roggeveld mountains, between Calvinia and Nieuwoudtville, and north of Loeriesfontein, is this shorter, semi-succulent form, which tends to break down into weedy succulent Karoo, with much *Salsola zeyheri*. It ranges in altitude from 2,000–3,300 feet above sea-level and receives five inches and less of rain mostly in winter.

(*a*) *Upper Form.*—The bushes grow up to three feet high, even *Pentzia incana*, which in the Central Upper Karoo and Central Lower Karoo, is usually only 2–6 inches high. Its lower branches continue to " anchor ", however, even though its upper branches may be inclined to adopt the spinescence of *Pentzia spinescens*. This is the dominant and characteristic bush of this veld type, except on excessively overgrazed hillsides, e.g. around Loeriesfontein, where *Galenia africana* becomes the dominant.

Typical species include:—

Pentzia sp. = A. 14409.
Galenia africana.
Eriocephalus sp. = A. 14,407.
E. ericoides.
Pteronia glauca.
P. glomerata.
P. incana (Namaqualand).
Zygophyllum gilfillani.
Salsola zeyheri (sometimes).
S. rabieana (sometimes).
Eriocephalus aspalathoides.
Pelargonium sp. = A. 14,118.
Euphorbia mauritanica.
E. stolonifera.
E. multiceps.
Nestlera prostrata (Roggeveld).
Walafrida articulata (Roggeveld)
Lebeckia spinescens (Namaqualand).
Lightfootia thunbergiana (Namaqualand).
Hermannia trifurcata (Namaqualand).
Pteronia divaricata.
Atriplex capensis.
Ruschia ferox.
R. tuberculosa (sometimes).
Drosanthemum ambiguum.
D. lique.
Asparagus capensis.
Galenia fruticosa.
Hirpicium alienatum.
Nestlera humilis.
Osteospermum sinuatum.
Cotyledon wallichii.
Asaemia axillaris.
Lycium spp.
Pterothrix spinescens.
Senecio sp. = A. 12,617.
Chrysocoma tenuifolia.
Zygophyllum microphyllum.
Helichrysum hamulosum.
Stomatium pyrodorum.
Aloinopsis malherbei.
Salvia rugosa.

Perennial grasses other than *Ehrharta calycina* and rarely *Danthonia stricta*, are very scarce in this veld type in its present condition.

Numerous patches of this veld type occur around the Kamiesberg on flattish parts of the higher ridges between the valleys, but too small and scattered to be mapped on a small scale. Many of them, where the gravelly soil is deep enough, have been ploughed up for growing wheat.

(*b*) *Lower Form.*—Exactly the same species occur in this form, though of normal stature and perhaps in different proportions, e.g. *Salsola zeyheri* tends to be common, but the Mesems are commoner and more species occur, in excessively overgrazed parts becoming dominant, e.g.:—

Drosanthemum eburneum.
Ruschia leucosperma.
R. pumila.
R. sp. cf. R. kakamasensis.
R. robusta.
Mesembryanthemum annuum.
M. sp.
Hymenocyclus framesii.
H. spp.
Brownanthus ciliatus.

R. fugitans.
Aridaria calycina.
A. rhodandra.
Psilocaulon utile.
Leipoldtia constricta.
Lampranthus uniflorus.
L. godmaniae.
L. watermeyeri.

and a lot more. The worst parts of this veld type, e.g. at the edge of the Tanqua Karoo and north and north-west of Loeriesfontein along the trek path into Bushmanland, have becone virtually desert. Here we find an extraordinary effect of excessive grazing pressure—the karoo-bushes of various species have been forced all to adopt exactly the same habit, a dense, woody, thorny, tangled " cushion ", with a few leaves inside the cushion. To determine them, one has to examine the leaves, no longer being able to recognize each species by its distinctive habit of growth.

29. The Arid Karoo.

(See Hutchinson, p. 181.)

This veld type, and the Succulent Karoo, occupy the driest parts of the Union, with a rainfall ranging from about two to seven inches per annum. The altitude of the Arid Karoo is mostly about 3,000 feet above the sea, sloping gently up to 4,000 feet along the southern margin and down to 1,500 feet along the edge of the Orange River valley in the north. The rain falls mostly in autumn, but is extremely erratic; it has been said that there is plenty of rain in Bushmanland, but it takes five years to get round to any particular farm. The country is extremely flat, with few hills, except in the southern portion along the northern foot of the Roggeveld mountains, where it undulates across the valleys of the Sak River and its numerous tributaries, all draining northwards into the Orange River. In their lower courses these rivers form enormous brak, silty flats, the " vloere ", in some cases covered with Ganna-veld (*Salsola salinissima* and other species), e.g. much of the Groot Vloer; in other cases practically bare, e.g. Verneuk Pan. In the 15 mile length of Verneuk Pan, the fall is said to be six inches. It is said, also, that after rains the thin layer of water which spreads over this flat surface is blown from side to side by the wind, producing a fine mud.

The country in general is no flatter than the western half of the Orange Free State or the Standerton area, but it gives a curious impression of convexity, as though it were a flat wide ridge, over the edge of which one cannot see; this impression has given the name Die Bult to a belt of country stretching south-east from Kenhardt and including the Kaiingbulte; but that part of Bushmanland west of the Sak River gives the same impression, and is, in fact, a region of internal drainage into numerous pans and vloere. This limited visibility is assisted by mirage and the fact that the complete circle of the horizon may be unbroken by even a rock. Westwards one may get an occasional glimpse of a distorted mirage, of the tips of the Kamiesberg peaks, wavering in the sky.

The Arid Karoo is by nature, an even grassier region that the Central Upper Karoo, but the chief grasses are silvery white desert species. In parts, because they can regenerate from seed more quickly and certainly than the karoo bushes, they have become the only perennial plants. Species of karoo bushes are plentiful, though sparser than in the Central Upper Karoo; but larger shrubs are rare and entirely absent over large areas.

There are three main variations:—

(*a*) Blomkoolganna veld (*Salsola tuberculata*) of calcareous tufa mostly along the northern edge of the plateau.

(*b*) Driedoring veld (*Rhigozum trichotomum*) of gravelly and stony soil, mostly in the central part.

(*c*) Semi-succulent Karoo of calcareous tufa and stony soil in the southern part, south of the Carnarvon–Calvinia main road.

(*a*) *Blomkoolganna Veld.*

It is likely that this is the climax of the whole of the Arid Karoo, but it has persisted best on sandy calcareous tufa, which occurs mainly in a belt along the north-eastern and northern borders of the veld type on granite, not extending much south of the Kenhardt–Pofadder road along the north border, but all down the north-eastern border, between the Doornberg and the Hartebeest River, to the neighbourhood of Prieska Poort. In some parts the tufa is covered with a layer of granite gravel. The veld is typically a uniform and fairly dense growth of *Salsola tuberculata* with *Aristida obtusa* and *A. ciliata*, and no other dominants, though the flora is quite rich. The ground is often surprisingly well covered also with short grasses, mainly *Enneapogon brachystachyus*, *Eragrostis denudata*, *Sporobolus sladenianus* and *Lepturella capensis*, with *Aristida brevifolia* in sandy depressions westwards. *Enneapogon* is short lived, though its dead tufts persist; *Lepturella* is too small to provide much cover; but the other two are perennials growing into mats up to 18 inches in diameter, but so short that in dry times the sand will drift over them, giving the impression that there is no grass at all. *Aristida brevifolia* is the hardiest of all the plants of the Arid Karoo, in droughts shedding its leaves and curling up into a little woody yellow-brown bush, even in parts where no other perennial survives. Annuals and geophytes are plentiful, though not so showy as those of Namaqualand. They include a fern, *Ophioglossum capense*. On the rare koppies and rocky outcrops, the vegetation is Namaqualand or Orange River Broken Veld, with a fringe of *Rhigozum trichotomum*. This shrub appears to be invading the blomkoolganna veld. Overgrazing, especially in the less arid parts, e.g. Die Bult, will tend to encourage other karoo bushes at the expense of *Salsola tuberculata*, producing a more mixed veld, but at the same time encouraging *Rhigozum trichotomum*.

Non-grasses of general occurrence are:—

Salsola tuberculata	10,331
Pentzia spinescens	4,531
Eriocephalus spinescens	1,649
Zygophyllum microphyllum	981
Hermannia spinosa	663
Nestlera humilis	619
Salsola glabrescens	610
Rhigozum trichotomum	496
Pteronia glomerata	452
Lycium oxycladum	378
Aptosimum abietinum	348
Ruschia ferox	221
Dicoma capensis	175
Eriocephalus pubescens	51
Moraea sp. = A. 12,611	9
Sarcocaulon patersonii	2

Non-grasses of less general occurrence include:—

Acanthopsis hoffmanseggiana.
Aizoon fruticosum.
Aptosimum depressum.
A. steingroeveri.
Berkheya annectens.
Aptosimum leucorrhizum.
Limeum aethiopicum.
Pteronia glauca.
P. inflexa.
P. mucronata.

Eriocephalus sp. = A. 12,634.
Geigeria passerinoides.
Tribulus terrestris.
Zygophyllum gilfillani.
Osteospermum armatum.
Monechma desertorum.
Euphorbia fusca.
Pentzia pinnatisecta.
P. leucoclada.
Lycium arenicolum h.
L. prunus-spinosa h.
L. austrinum. k.
Phaeoptilum spinosum.
Plinthus karrooicus.
Polygala seminuda.
Selago minutissima.

and many more.

Grasses of general occurence are:—

Aristida obtusa........	111,526
Enneapogon brachystachyus	64,624
Aristida ciliata.........	16,942
Eragrostis denudata....	11,008

These are surprising figures when one compares them with the figures for the northern grassveld types and the bushveld types. They are supported, however, by Tidmarsh Wheel analyses made at Jagbult on Die Bult and at Towoomba Research Station in the Sourish Mixed Bushveld, which showed that basal cover at Jagbult (6–9 per cent.) was actually higher than at Towoomba (5–8 per cent.).

Grasses (including annuals) of less general occurrence are:—

Aristida brevifolia.
A. congesta.
A. curvata.
Sporobolus sladenianus.
Eragrostis annulata.
E. hygrophila.
E. porosa.
Tragus racemosus.
Schmidtia kalahariensis.
Enneapogon scaber.
Lepturella capensis.
Panicum lanipes.
Stipa namaquensis.

Annuals and geophytes are very numerous and important after good rains, which means that they are rarely seen in quantity; they include:—

Aizoon canariense.
Allenia urens.
Amellus strigosus.
Androcymbium bellum.
A. roseum.
Arctotis staechadifolia.
Babiana hypogaea.
Diascia engleri.
Dimorphotheca polyptera.
Dipcadi spp.
Eriospermum spp.
Euphorbia inaequilatera.
Galenia sarcophylla.
Gnaphalium glomerulatum.
Helichrysum spp.
Heliophila trifurcata.
Hermannia paucifolia.
Ifloga paronychioides.
Indigofera argyraea.
Lepidium desertorum.
Limeum capense.
Lotononis leobordea.
Manulea fragrans.
Medicago aschersoniana h. & w.
Oxalis pulchella var. beneprotecta.
Ophioglossum capense.
Pentzia annua.
Walafrida minuta.
Sesamum capense.
Sutera tristis.
Ursinia nana.
Zaluzianskya diandra.
Zygophyllum simplex.
Bergia anagalloides.

It is likely that the prickly and inedible *Osteospermum armatum* will become of increasing importance in the future, in the Driedoring veld too.

The total number of species in the Relative Abundance Table is 284.

(*b*) *The Driedoring Veld.*

This is stony veld, mostly on Dwyka shales and tillite and Ecca shales, ranging in colour from brown to black. The soil, what there is of it, is silty rather than sandy or gravelly.

Almost the whole of this form of the Arid Karoo has been reduced by the trek boer to virtual desert; and, in its dark, featureless desolation and its shimmering heat and mirages, it is not attractive country.

Here and there one finds parts where *Salsola tuberculata* is still the dominant bush, with abundance of *Aristida obtusa* and sometimes, westwards, *A. brevifolia*, and wherever there is calcareous tufa. The general bareness of this veld is not a natural condition, but rather the result of continuous grazing and the excessive heating of the exposed dark surface. The generally dominant bush is *Pentzia spinescens*, with *Eriocephalus spinescens* important in the dark stony parts, with *Zygophyllum microphyllum*, *Pteronia leucoclada* and *Salsola zeyheri* usually very sparse. *Rhigozum trichotomum* tends to occur in patches and narrow belts, forming more or less a honeycomb pattern. Succulents are sometimes fairly common, e.g. *Ruschia ferox*, *R. leucanthera* and *R. muricata*, besides the temporary *Psilocaulon* spp. of the pans and " vloere ", increasing in importance in those parts which we have separated as False Succulent Karoo.

Non-grasses of general occurence are:—

Pentzia spinescens	4,118
Salsola tuberculata	2,892
Galenia sarcophylla	2,851
Ruschia ferox	1,824
Eriocephalus spinescens	1,739
Zygophyllum microphyllum	1,662
Rhigozum trichotomum	882
Zygophyllum gilfillani	856
Aptosimum depressum	701
Pteronia mucronata	650
Hermannia spinosa	517
Eriocephalus ericoides	514
Pteronia glomerata	314
Tetragonia arbuscula	53
Lycium arenicolum	35

Non-grasses of less general occurrence are:—

Leyssera tenella	1,618
Gazania lichtensteinii	1,447
Mesembryanthemum annuum	1,055
Salsola zeyheri	1,007
Zygophyllum simplex	823
Aridaria tetragona	625
Aptosimum steingroeveri.	464
Gazania spp	464
Osteospermum sinuatum.	455
Aridaria sp. §. Noctiflora	373
Limeum aethiopicum	366
Aster hyssopifolius	347
Pteronia glauca	245
and many more.	
Psilocaulon absimile	236
Nestlera humilis	227
Dimorphotheca polyptera	217
Aptosimum abietinum	136
Dicoma capensis	118
Helichrysum lucilioides	89
Mesembryanthemum sp.	78
Osteospermum armatum	50
Lebeckia spinescens	20
Pteronia leucoclada	15
Euphorbia rectirama	14
Pteronia inflexa	14
Berkheya annectens	13

Grasses of general occurrence are:—

Aristida obtusa	20,997
A. ciliata	12,662
Enneapogon brachystachyus	10,381
Aristida curvata	805

Grasses of less general occurence are:—

Aristida congesta	1,841
Stipa namaquensis	349
Fingerhuthia africana	256
Aristida namaquensis	12

At times annuals are abundant, but the writer has not seen this part of the country after good and sustained rains.

In 1939 a survey was made of the tramped-out, though partially rested farm, Rietkolk Oos, nine miles north of Brandvlei, and an actual count made of the plants occurring within 1,219 four-foot quadrats distributed along a zig-zag line at 100 pace intervals. The figures (worked out as per morgen) may be of interest:—

Aristida obtusa	5,454
Salsola tuberculata	3,001
Pentzia spinescens	2,738
Zygophyllum microphyllum	2,199
Z. gilfillani	1,343
Eriocephalus spinescens	1,240
Enneapogon brachystachyus	1,208
Rhigozum trichotomum	1,028
Psilocaulon absimile	710
Berkheya annectens	710
Osteospermum armatum	360
Tetragonia arbuscula	355
Hermannia spinosa	295
Nestlera humilis	250
Aristida ciliata	226
Brownanthus ciliatus	198
Limeum aethiopicum	134
Pteronia mucronata	129
P. sp	124
Asparagus compactus	115
Lycium oxycladum	111
Psilocaulon sp	97
Hermannia paucifolia	74
Polygala seminuda	74
Pteronia inflexa	69
Dicoma capensis	55
Trianthema parvifolia	55
Aptosimum abietinum	41
Aridaria tetragona	41
Phaeoptilum spinosum	41
Eriocephalus ericoides	37
Aptosimum leucorrhizum	37
Galenia africana	32
Sarcocaulon patersonii	28
etc.	

The total number of species recorded on this farm was 97, while in the Relative Abundance Table for the Driedoring Veld are 335 species.

It sometimes happens in the barer parts of this veld eastwards that a complete cover of *Tribulus* spp. will appear after rain.

(*c*) *The Semi-Succulent Southern Form of Arid Karoo.*

This occurs both on calcareous tufa and on stony soil, and is not so flat, nor so arid. It is dominated by *Salsola tuberculata* (including a form which links this species with *S. rabieana*), but less completely than in the Blomkoolganna veld, this veld being more mixed. *Rhigozum trichotomum* does not occur, except along the northern margin. *Aristida obtusa* and *A. ciliata* are still the commonest grasses, but the Mesems are more plentiful.

Typical species are:—

Salsola tuberculata.
S. tuberculata forma.
S. glabrescens.
Eriocephalus spinescens.
E. ericoides.
E. sp. = A. 12,634.
Pentzia spinescens.
Pteronia mucronata.
P. glauca.
P. inflexa.
P. adenocarpa.
Fresenia scaposa.
Drosanthemum framesii.
D. ambiguum.
D. lique.
Nestlera humilis.
Osteospermum sinuatum.
Delosperma subincanum.
Hymenocyclus sp.
Euryops multifidus (E. part).
Euphorbia stolonifera.
Aridaria noctiflora.
A. glandulifera.
Brownanthus ciliatus.

Ruschia ferox.
R. muricata.
Zygophyllum gilfillani.
Z. microphyllum.
Helichrysum lucilioides.
Polygala pungens.
Hermannia spinosa.
H. pallens.
Hirpicium alienatum.
Trichodiadema pomeridianum.

and many more, with *Lycium* spp. more plentiful than in Form (*a*).

30. Central Lower Karoo.

(See Hutchinson, p. 439.)

This veld type is related to the Arid Karoo and also occupies flat, stony country, but at a rather lower elevation of 2,400–3,500 feet, and not quite so arid, receiving 5–10 inches of rain per annum, nowhere less than five inches. It is partly on calcareous tufa, partly on stony sandstone and shale and partly on silty flats and flood plains. The flora is much like that of the Arid Karoo but shorter and denser, sometimes so dense as to be almost a complete cover; it shows a resemblance, too, to the short, dense Arid Karoo-invaded veld of silty flats in the Central Upper Karoo (p. 93). *Pentzia incana* (ankerkaro) and *Ruschia vulnerans* and other succulents play an important part, while the grasses, predominantly *Aristida obtusa* and *A. ciliata*, are of Arid Karoo type. Along the Kariega River and its tributaries, the thornveld shows traces of having been densely grassy.

Typical species are:—

Salsola tuberculata.
Pentzia incana (ankerkaro).
Eriocephalus spinescens.
Ruschia vulnerans.
R. ferox.
Zygophyllum microphyllum.
Aster filifolius.
Hermannia grandiflora.
H. cuneifolia.
Aptosimum steingroeveri.
Plinthus karrooicus.
Osteospermum microphyllum.
Aster muricatus.
Asparagus sp. (stiff glaucous).
Nestlera humilis.
N. conferta h.
Justicia orchioides h.
Acacia karroo W.
Rhus lancea W.
Gymnosporia buxifolia W.
Royena pallens W.
Psoralea obtusifolia W.
Lebeckia spinescens.
Asparagus sp.
Gazania rigens.
Allenia urens h.
Walafrida geniculata h.
Sutera atropurpurea W.
Pteronia erythrochaeta W.
Zygophyllum gilfillani.
Aridaria tetragona.
Drosanthemum framesii.
D. lique.
Phymaspermum pubescens.
Eriocephalus ericoides.
Pteronia adenocarpa.
Limeum aethiopicum.
Ruschia uncinella h.
Gamolepis trifurcata h.
Zygophyllum incrustatum h.
Osteospermum spinescens h.
Asaemia axillaris h.
Lycium arenicolum h.
L. prunus-spinosa h.
L. spp. h.
Aristida obtusa.
A. ciliata.
A. uniplumis forma.
A. curvata.
Enneapogon brachystachyus.
Fingerhuthia africana.
Cynodon incompletus.
Eragrostis lehmanniana.
E. bicolor W.
Panicum stapfianum W.
Digitaria sp. W.
Panicum maximum W.
Sporobolus usitatus W.

Hymenocyclus uitenhagensis h.
Delosperma multiflorum h.
Stipa namaquensis.
Tragus racemosus.
Chloris virgata.
Lepturella capensis.

and many more, a very well mixed Karoo.

Low stony ridges (hills are non-existent) are transitional to Karroid Broken Veld with *Rhigozum obovatum* and a variety of other species belonging to that veld, including the grasses.

In this denser veld, annuals are less important than they are in the Arid Karoo; *Galenia* spp. are the commonest. It gives the impression of being better preserved than much of the Arid Karoo, and, as in that veld type, it is the darkly stony parts that are usually the worst in appearance, sometimes being virtually desertlike.

31. Succulent Karoo.

This is the veld of the low altitude, hot, arid areas with a winter or through the year rainfall. Rainfall ranges from about 2–8 inches per annum, and altitude from 0–2,000 feet above sea-level. It is dominated by succulents, mainly Mesems, with few trees or large shrubs, except along the rivers, which are lined with *Acacia karroo*, *Tamarix austro-africanae*, *Rhus lancea* and a few other species. This dominance of the Mesems, however, is probably in part an artificial condition, just as it is in the Little Karoo.

There are three main forms of this veld: (*a*) The Namaqualand Coast Belt; (*b*) The Tanqua Karoo, with outliers in the valleys along the northern foot of the Swartberg; (*c*) The Steytlerville Karoo.

(*a*) *The Succulent Karoo of the Namaqualand Coast Belt.*

(See Marloth I, Pl. 53B; II, 1, Pl. 34; II, 2, Fig. 96; White, Dyer and Sloan, Figs. 190, 276.)

Here the Succulent Karoo occurs both on the sand of the coastal plain and the heavier, stony soil of the foothills. The Mesems are particularly dominant, ranging in habit from almost subterranean, stemless dwarfs to eight-foot shrubs. Rainfall ranges from 2–5 inches per annum, falling in winter, but aridity is reduced by sea-mists; altitude ranges from sea-level up to about 1,500 feet. A curious feature of this region (and of the rest of the coast belt southwards) is the " heuweltjies ", or mounds. They appear to have been formed by clumps of bush growing on termitaria; both bush and termitaria can still sometimes be found associated with them. Except in the south around Vanrhynsdorp, and in the north near Port Nolloth, this veld gives the impression of being in good condition.

Of the Mesems we can mention:—

Ruschia caroli.
R. bolusiae.
R. viridifolia.
R. bipapillata.
R. tuberculosa.
R. leucosperma.
R. utilis.
R. frutescens.
R. robusta.
R. comptonii.
R. fugitans.
R. testacea.
R. conjuncta.
Lampranthus lunatus.
Leipoldtia nelii.
Mesembryanthemum annuum.
M. sedentiflorum.
M. stenandrum.
Hymenocyclus framesii.
Rhinephyllum macradenium.
Monilaria sp.
Psilocaulon utile.
P. rapaceum.
P. corallinum.
P. acutisepalum.
P. foliosum.

R. rariflora.
R. mucronifera.
R. langebaanensis.
R. decurvans.
R. hutchinsonii.
Drosanthemum eburneum.
D. diversifolium.
D. subalbum.
Aridaria calycina.
A. framesii.
A. trichotoma.
A. dela.
A. watermeyeri.
Lampranthus uniflorus.
L. watermeyeri.
Conophytum minutum.
C. calculus.
C. wettsteinii.
Prenia pallens.
Cephalophyllum curtophyllum.
C. spongiosum.
C. pittenii.
Argyroderma spp.
Cheiridopsis cuprea.
C. denticulata.
Dactylopsis digitata.
Conicosia alba.
Vanzylia annulata.
Apatesia sabulosa.

This list, however, is little better than a random sample of the wealth of Mesems in this veld. Among other succulents are:—

Euphorbia mauritanica.
E. mundii.
E. hamata.
E. loricata.
E. decussata.
E. burmannii.
E. schönlandii.
Cotyledon wallichii.
C. ventricosa.
C. decussata and others.
Caralluma winkleri.
Huernia spp.
Stapelia spp.
Crassula obvallata.
C. lycopodioides.
C. globosa.
C. pearsonii and many more.
Augea capensis.
Senecio sp.
Othonna floribunda.
Adromischus mammilaris.
A. sphenophyllus.
Aloe krapohliana.
A. arenicola and others.
Sarcocaulon burmanii.
S. l’heritieri.

and many more, whilst the non-succulents and semi-succulents include:—

Salsola zeyheri.
Galenia fruticosa.
G. africana.
Berkheya obovata.
B. fruticosa.
Pteronia sp. (Kambrobos).
Salsola sp.
Asparagus capensis.
A. stipulaceus.
Zygophyllum retrofractum.
Z. lichtensteinianum.
Z. stapfii.
Z. spinosum.
Osteopsermum sinuatum.
Hirpicium alienatum.
Chrysocoma longifolia.
Hermannia multiflora.
Pelargonium fulgidum.
Spergularia marginata var.
Tetragonia spicata.
T. decumbens.
Atriplex capensis.
Blackiella inflata.
Manochlamys albicans.
Kochia pubescens.
Helichrysum leipoldtii.
Hoplophyllum spinosum.
Didelta carnosa.
Pteronia namaquensis.
Sutera fruticosa.
Lycium spp.
Arthrocnemum pillansii.
Pteronia inflexa.
P. sp.cf. P. glabrata.
Thesium spinosum.
Lebeckia multiflora.
Sisyndite spartea W.

and a few grasses:—

Ehrharta calycina.
Lasiochloa longifolia.
Stipa tortilis.
Aristida obtusa (inland parts).

Pentaschistis spp.
P. sp. (=A. 14796).
Schismus fasciculatus.
Chaetobromus schraderi.
Urochlaena pusilla.

The white annual, *Stipa tortilis*, is sometimes abundant, especially on the " heuweltjies ", while a red-flowered, annual form of *Ehrharta calycina* is sometimes abundant enough to colour the veld in parts; it was formerly mown for hay.

A large number of annuals and bulbous plants could be named, but a discussion of this part of the flora will be postponed until after it has been studied in a good flowering season. This depends on a good succession of winter and spring rains.

(*b*) *The Tanqua Karoo.*

[See Marloth I, Pl. 46, 53B; III, 1, Fig. 13; Hutchinson, facing p. 193 (Prince Albert.)]

This occupies the valley of the Tanqua and Doorn Rivers, flat country at elevations ranging from 700–2,500 feet, mostly 1,000–1,500 feet above the sea. It is enclosed by mountains which cut off the rain to the extent that the whole valley receives less than five inches per annum, falling mostly in winter. It is terribly tramped out, and eroded down to the bare shale, the lower part of it, in the angle between the Tanqua and Doorn Rivers, being almost total desert. The better parts are a short succulent karoo, many of the mesems being of the stemless type; non-succulents also occur and so does *Aristida obtusa*, even becoming abundant after good rains. Annuals and geophytes are numerous as regards species, but rarely seen.

In the better parts, the following will be found, and many more, especially amongst the Mesems, annuals and geophytes:—

Ruschia ferox.
R. sp. = 14461.
R. leucosperma.
R. aculeata.
R. crassa.
Aridaria tetragona.
A. blanda.
A. noctiflora.
A. glandulifera.
Rhinephyllum macradenium.
R. luteum.
Pleiospilos prismaticus.
Brownanthus ciliatus.
Cephalophyllum curtophyllum.
Echinus geminatus.
Lampranthus uniflorus.
Drosanthemum lique.
D. eburneum.
Aridaria rhodandra.
Hereroa fimbriata.
H. latipetala.
H. stanleyi.
H. odorata.
Psilocaulon utile.
Mesembryanthemum chrysum.
Sceletium spp.
Tamarix austro-africanae W.
Salsola aphylla W.
Suaeda fruticosa W.
Nicotiana glauca W.
Pteronia glauca. l.
Eriocephalus spinescens.
Osteospermum sinuatum.
Arthrosolen sp. =A. 14458.
Euphorbia decussata.
E. mauritanica.
E. mundii.
Hoodia gordoni.
Tetragonia sp.
Sarcocaulon burmannii.
S. patersonii.
Crassula cornuta.
C. spp.
Adromischus spp.
Caralluma inversa.
Cotyledon wallichii l.
C. reticulata.
Augea capensis.
Lycium arenicolum.
Asparagus capensis.
A. sp.
Homeria speciosa.

Galenia fruticosa.
G. africana.
Salsola zeyheri.
S. sp. (=A. 14455).
Monechma pseudopatulum.
Zygophyllum retrofractum.
Pituranthos aphylla W.
Acacia karroo W.
Rhus lancea W.
Tritonia sp. cf. T. flava =A. 14456.
Cyphia comptonii.
Europys annuus.
Amellus strigosus.
Aster bergerianus.
Hebenstreitia integrifolia.
H. parviflora.
Lotononis leptoloba.

As in the Steytlerville Karoo, the creeping species of Mesem are sometimes abundant on silty flats.

Grasses are scarce in this veld; they include:—

Aristida obtusa.
A. ciliata.
A. namaquensis.
Cladoraphis spinosa.
Enneapogon brachystachyus.

(*c*) *The Steytlerville Karoo.*

(See White, Dyer and Sloane, Fig. 677.)

This, too, is flat country but is mostly silty rather than stony, so that the creeping Mesems. are here important, e.g. *Hymenocyclus uitenhagensis* and *Aridaria splendens.* Typical species are:—

Pentzia incana (ankerkaro).
Ruschia vulnerans.
Salsola tuberculata forma.
Zygophyllum microphyllum.
Aster muricatus.
Drosanthemum fourcadei.
Eriocephalus ericoides.
Hymenocyclus luteolus.
H. uitenhagensis.
Aridaria splendens.
Delosperma multiflorum.
Lycium oxycladum.
Euphorbia inermis.
Blackiella inflata.
Psilocaulon spp.
Mesembryanthemum spp. (annuals).
Glottiphyllum semicylindricum.
Kochia pubescens.
Gamolepis trifurcata.
Asparagus sp. (= A. 11908).
Galenia sp. (= A. 13224).
G. sarcophylla.
Augea capensis.
Chrysocoma tenuifolia.
Aloe variegata (rare).
A. longistyla (rare).

and many more, in good samples a dense veld. If this is False Succulent Karoo, in its original condition it would have been Central Lower Karoo. Where is it tramped out, permitting wind erosion to occur, the creeping Mesems tend to build up low hummocks. Grasses are scattered all through, e.g.:—

Aristida diffusa var. burkei.
A. obtusa.
A. ciliata.
Sporobolus fimbriatus.
S. usitatus.
S. ludwigii.
Digitaria argyrograpta.
Eragrostis lehmanniana.
E. curvula.
E. obtusa.
Tragus koelerioides.

Aristida diffusa var. *burkei* occurs especially on low stony rises, while on the flats, *Tragus koelerioides* and *Sporobolus usitatus*, with the annuals, *Aristida curvata* and *Chloris virgata* are sometimes abundant. Where the Grahamstown–Port Elizabeth Road crosses the Sundays River valley, outliers of this veld will be found, replacing the stunted scrub of the saline flats.

32. ORANGE RIVER BROKEN VELD.

(*a*) The typical form of this veld type occupies steep, rocky mountains, on which grow *Aloe dichotoma*, and *Euphorbia avasmontana.* It occurs between Prieska and Kakamas, at the latter place beginning a gradual transition to Namaqualand Broken Veld.

(*b*) It occurs also very extensively on gravelly and stony plains, where it is predominantly *Rhigozum trichotomum* veld.

(*c*) Above Prieska it occurs on rolling stony country in the valley and is predominantly *Acacia detinens* veld. It is this third form which is spreading up the valleys of the Vaal-Hartz and Orange Rivers as False Orange River Broken Veld. Below Prieska, all these variations will occur together, according to the topography.

(*a*) *Typical Orange River Broken Veld.*

[See Hutchinson, facing pp. 64 (Koegas), 192 and 193 (Prieska), 320 (Koegas); Reynolds, Pl. 74; White, Dyer and Sloane, Fig. 918.]

The presence of *Aloe dichotoma* with *Euphorbia avasmontana* makes this veld type quite unmistakable. Just as the valley bushveld and related types are adaptations of the eastern coastal branch of the tropical flora to arid conditions, so the Orange River Broken Veld is an adaptation of the central branch of the tropical flora, while the Namaqualand Broken Veld is not only an adaptation of the west coastal and central branches, but also of certain elements of the eastern branch which have worked their way right along the coast. The Orange River Broken Veld also has a few elements of the east coastal flora and of the west coastal flora, which have come up the Orange River valley or else across the eastern part of the upper plateau where now is False Karoo.

The typical Orange River Broken Veld occurs on a variety of rocks, e.g. banded ironstone, dolomite, quartzite and granite. Altitude ranges from 2,400–4,500 feet above sea-level and rainfall from about 6–13 inches per annum. Owing to its proximity to the permanent water of the Orange River, it is, as a rule, badly tramped out.

Typical trees and shrubs include:—

Aloe dichotoma.
Euphorbia avasmontana.
Sarcostemma viminale forma.
Acacia detinens.
A. karroo W.
A. giraffae.
Rhus lancea W.
R. viminalis W.
R. undulata var. burchellii.
R. dregeana.
Salix capensis W.
Tarchonanthus minor.
Phaeoptilum spinosum.
Ziziphus mucronata.
Rhigozum trichotomum.
R. obovatum.
Lycium austrinum.
Ehretia rigida.
Boscia albitrunca.
Cadaba juncea.
Putterlickia pyracantha.
Nymania capensis.
Ficus ingens.
Olea africana.
Grewia flava.
with *Tamarix austro-africanae*

coming up the Orange River nearly as far as Koegas.

The smaller plants include:—

Barleria rigida.
Monechma spartioides.
Aizoon burchellii.
Orygia decumbens.
Rhynchosia totta.
Asparagus stipulaceus.
Antizoma capensis.
Rogeria longiflora.

Sericocoma avolans.
Pachypodium succulentum.
Asclepias burchellii.
Chrysocoma tenuifolia.
Dicoma capensis.
Eriocephalus pubescens.
Aster muricatus.
Euryops multifidus.
Garuleum schinzii.
Geigeria passerinoides.
Helichrysum lucilioides.
Senecio longiflorus.
Pegolettia retrofracta.
Pentzia sphaerocephala.
P. argentea.
Pteronia glauca.
P. unguiculata.
Chascanum garipense.
Osteospermum microphyllum.
Euclea ovata.
E. undulata.
Phyllanthus maderaspatensis.
Lasiocorys capensis.
Stachys burchellii.
Indigofera heterotricha.
I. patens.
Adenium oleifolium.
Argemone. mexicana. w.
Kissenia capensis.
Codon royeni.
Forskohlea candida.
Trichodesma africanum.
Dyerophytum africanum.
Limeum aethiopicum.
Talinum caffrum.
Thesium lineatum.
Aptosimum abietinum.
Sutera argentea.
Aloe hereroensis.
Hermannia abrotanoides.
H. candidissima.
H. helianthemum.
Chascanum pinnatifidum.
Lantana salvifolia.
Tribulus terrestris.
T. zeyheri.
Berkheya oppositifolia.
Tetragonia arbuscula var. latifolia.
Cleome diandra.
Salvia garipensis.
Euphorbia glaucella.
E. spinea.
Justica thymifolia.
Zygophyllum suffruticosum.

and many more, a rich flora, though a sparse vegetation. This list was extracted mostly from an uncompleted Relative Abundance Table which was made 14 years ago for all the veld types of Griqualand West, in which the families were arranged alphabetically and the genera and species likewise. In the other lists the species are arranged very roughly in order of importance.

In the typical Orange River Broken Veld grasses are important and include:—

Aristida diffusa var. burkei.
Digitaria smutsii.
Cenchrus ciliaris.
Cymbopogon plurinodis.
Enneapogon scaber.
E. scoparius.
Eragrostis curvula.
E. denudata.
E. lehmanniana.
Fingerhuthia africana.
Eustachys paspaloides.
Panicum stapfianum.
Sporobolus fimbriatus.
Lepturella capensis.
Tricholaena capensis.

In the Kakamas neighbourhood, a number of species of northern, southern and western affinity occur (although *Aloe dichotoma* and *Euphorbia avasmontana* are still present), e.g. *Leucosphaera bainesii*, *Euphorbia dregeana*, *Microloma incanum*, *Thamnosma africanum*, *Boscia foetida*, *Setaria appendiculata*, *Triraphis ramosissima*, *Commiphora oblanceolata* (A. 14246), *Montinia caryophyllacea*, *Antherothamnus rigida*, *Cryptolepis decidua*, *Berkheya canescens*, *Aridaria* sp. =A. 14381, *Helichrysum benguellense*, *Geigeria vigintisquamea*, *Pappea schumanniana*, *Schotia speciosa*, *Ruschia kakamasensis*, *Aridaria ausensis*, *Hereroa bergeriana* and *Pentamenes dufftii*.

(*b*) *The Rhigozum trichotomum Veld of the Plains.*

[See Hutchinson, facing p. 192 (Koegas); White, Dyer and Sloane, Fig. 181.]

This is a simpler veld; the dominant shrub is *Rhigozum trichotomum*, sometimes growing densely, sometimes scattered, but usually tending to spread into clumps by means of its stolons. In sandy valleys it grows up to six or seven feet tall, but usually it is two to three feet tall. At the upper margin of the Orange River Broken Veld, where it merges into the Arid Karoo, this may be the only shrub, but, as a rule, it is accompanied by a few other shrubs and dwarf trees, especially *Boscia albitrunca*, *B. foetida*, *Phaeoptilum spinosum*, *Acacia detinens* and *Parkinsonia africana*. In this veld there are more karoo bushes than in the typical form; in fact, all of those of the Arid Karoo, but in different proportions—thus *Salsola tuberculata* is scarce. There are also some additions, e.g. *Zygophyllum dregeanum*, *Z. suffruticosum*, *Aloe claviflora*, *Aptosimum marlothii* and *Euphorbia gariepina*; while the grasses are dominantly *Aristida obtusa* and *A. ciliata*, in addition *Cenchrus ciliaris*, *Eragrostis lehmanniana* and the annuals *Eragrostis porosa*, *E. annulata*, *E. echinochloidea*, *E. brizantha*, *Schmidtia kalahariensis*, *Triraphis fleckii* and *Aristida barbicollis* are important. A grass which was probably formerly an important grazing species is *Panicum lanipes*, now rare, others are *Danthonia glauca* and *Aristida engleri*, even rarer. *Aloe claviflora* is sometimes common on sandy calcareous tufa. In extreme cases of overgrazing the last survivors of this veld may be *Rhigozum* and *Augea capensis*.

(*c*) *The Acacia detinens Veld.*

(See Reynolds, Pl. 34.)

Although not confined to the part of the Orange River valley above Prieska, this variation of the Orange River Broken Veld is there best developed and most extensive. It is associated with calcareous tufa often of great depth, littered with stones; in fact, patches of it which occur in the valleys below Prieska, amongst the volcanic hills, are so stony as to be known locally as the Swartklipveld. This veld is a fairly dense growth of *Acacia detinens*, six to eight feet high, with a great variety of karoo bushes and grasses.

Other trees and shrubs are:—

Rhus undulata var. burchellii.
Rhigozum obovatum.
R. trichotomum.
Boscia albitrunca.
Cadaba juncea.
Phaeoptilum spinosum.
Ziziphus mucronata.
Lycium spp.
Grewia flava.
Olea africana (kloofs).

The smaller plants include:—

Acanthopsis hoffmannseggiana.
Barleria lichtensteiniana.
B. rigida.
Monechma desertorum.
Aizoon burchellii.
A. fruticosum.
Plinthus karrooicus.
Trianthema parvifolia.
Cyphocarpa angustifolia.
Hoodia gordoni.
Pentzia globosa.
P. lanata.
Pteronia mucronata.
P. glauca.
P. unguiculata.
Lasiocorys capensis.
Sylitra biflora.
Asparagus stipulaceus.
Ornithoglossum viride.
Limeum aethiopicum.

Stapelia flavopurpurea.
Tavaresia barklyi.
Cleome diandra.
Eriocephalus ericoides.
E. pubescens.
E. spinescens.
Aster muricatus.
Garuleum schinzii.
Geigeria passerinoides.
G. pectidea.
Senecio longiflorus.
Nestlera humilis.
Pegolettia retrofracta.
Pentzia argentea.
Lophiocarpus burchellii.
Polygala asbestina.
Thesium lineatum.
Aptosimum abietinum.
A. albo-marginatum.
Sutera pinnatifida.
Hermannia abrotanoides.
H. spinosa.
Melhania rupestris.
Fagonia minutistipula.
Zygophyllum microphyllum.
Tribulus terrestris.
T. zeyheri.
T. cristatus.

with the following grasses:—

Aristida curvata.
Digitaria sp.
Cenchrus ciliaris.
Cypholepis yemenica.
Fingerhuthia africana.
Enneapogon brachystachyus.
E. scaber.
Eragrostis denudata.
Sporobolus fimbriatus.
Lepturella capensis.

i.e., a fairly complete Karoo flora, but lacking the Mesems: a few occur, but are rare. Grasses were certainly formerly more plentiful, and it is potentially good veld.

33. Namaqualand Broken Veld.

This veld type has three variations: (*a*) the Typical Form of the dome shaped granite hills and the rarer quartzite hills; (*b*) the *Rhigozum trichotomum* veld of the gravelly plains in the Orange River valley; (*c*) the False Desert grassveld which results from the grazing out of the karoo bushes in the more open parts of (*b*).

(*a*) *The Typical Form of the Namaqualand Broken Veld.*

(See Hutchinson, pp. 157, 159, 162, 163, 173; Reynolds, Pl. 73, Figs. 551, 552, Pl. 75, Figs. 556, 557, 446; King, Fig. 129.)

This is characterized by *Aloe dichotoma* and is mainly distinguished from the Orange River Broken Veld by the absence of *Euphorbia avasmontana* and by the importance of succulents, both Mesems. and others. The rain falls in winter, amounting to about 5–12 inches per annum, while altitudes range from 1,000–4,500 feet above the sea. It is a taller and denser veld than the Orange River Broken Veld and has resisted overgrazing better, because of the inedible nature of so many of the succulents. A good deal of soil erosion nevertheless occurs. The country is very broken and steep, and, as in the Spekboomveld, we find an aspect difference—on southern aspects, especially at higher altitudes, the vegetation is less succulent and taller, forming a scrub. The granite " domes " that make Namaqualand so picturesque, also encourage a surprising amount of shrubbiness by increasing the effective rainfall on the slopes below them. The northern part of this veld, in the Richtersveld, has not been studied during this survey; here occur *Aloe pillansii* and *Pachypodium namaquanum.*

The principal trees and shrubs are:—

Aloe dichotoma.
A. pillansii (Richtersveld).
Pachypodium namaquanum (Richtersveld).
Rhus undulata var. genuina forma undulata.
R. horrida.
Heeria concolor.
Acacia karroo W.
A. giraffae W.
Tamarix austro-africanae W.
Boscia albitrunca. W.
Euphorbia dregeana.
Othonna arbuscula.
Ficus ingens.
F. gurichiana.
Dodonaea thunbergiana.
Gymnosporia laurina.
Putterlickia pyracantha.
Euclea undulata.
E. tomentosa.
Erythrophysa undulata.
Royena sp. = A. 14240.
Pappea schumanniana.
Aloe khamiesensis.
Ruschia frutescens.
R. utilis.

The smaller plants include:—

Galenia africana.
G. fruticosa.
Euphorbia mauritanica.
E. burmannii.
E. mundii.
Pteronia incana.
P. sp. (kambrobos).
Zygophyllum morgsana.
Antizoma miersiana.
Ruschia caroli.
R. viridifolia.
R. ferox.
R. robusta and many more.
Crassula pearsonii.
Octopoma spp.
Dyerophytum africanum.
Hermbstaedtia glauca.
Tetragonia spp.
Osteospermum glabratum.
Sisyndite spartea W.
Montinia caryophyllacea.
Lebeckia sericea.
Didelta spinosa.
Teedia lucida.
Eriocephalus ericoides.
E. umbellatus.
Othonna floribunda.
Senecio corymbiferus.
S. cotyledonis.
S. junceus.
Ceraria namaquensis.
Pelargonium squarrosum.
P. crithmifolium.
Cotyledon wallichii.
C. paniculata.
Berkheya obovata.
Thesium lineatum.
Stachys multiflora.
Euryops tenuissimus.
Othonna sp. (A. 15094.)
O. (Doria abrotanifolia).
O. aeonioides.
Lycium spp.
Sarcocaulon l'heritieri.
Caralluma winkleri.
Chrysocoma coma–aurea.

with a great variety of smaller Mesems., *Crassula* spp., *Adromischus* spp., *Pelargonium* spp., *Stapeliads* and *Cotyledon* spp., as well as annuals and bulbous plants.

The less succulent scrub of southern aspects is dominated by *Pteronia leptospermoides*, *P. undulata*, *P. divaricata*, *Salvia dentata*, *Rhus horrida*, *Eriocephalus umbellatus* and *Indigofera pungens*. This scrub merges easily into the Western Mountain Karoo which occurs generally on what flattish parts there are on the higher ridges between the valleys, where there is some depth of gravelly soil.

Grasses are sparse, though many species occur, many of southern type, e.g.:—

Ehrharta calycina.
Danthonia stricta.
Pentaschistis spp. (annual).
Enneapogon scaber.
Bromus spp. (annuals).
Trisetum pumilum W.

P. brachyanthera.
Chaetobromus dregeanus.
Fingerhuthia africana.
Schismus fasciculatus.
Cymbopogon plurinodis.
Aristida engleri.

The outliers of this veld type occurring on the scattered hills and mountains up the Orange River valley, have a few other species:—

Monechma molle.
M. fimbriatum.
Cryptolepis decidua.
Commiphora oblanceolata.
Boscia foetida.
Zygophyllum meyeri.
Rhus populifolia.
Bauhinia garipensis.
Euclea pseudebenus W.
Maerua gilgii TW.
Phaeoptilum spinosum.
Rhigozum trichotomum.
Royena glandulosa.
Nymania capensis.
Schotia speciosa.
Gymnosporia lanceolata.

while the grasses are the same as in the lower part of the Orange River Broken Veld.

Between Pofadder and the Orange River, in the Kaboop valley, occur some curious and extensive " forests " of *Aloe dichotoma*, on granite gravel slopes below the hills, an unusual habitat for this species. In 1948 it was noticeable that the trees further down the slopes were mostly dead, whereas those further up were still flourishing, suggesting perhaps that, for the first time in the long life of these plants, there was insufficient water draining from the hills, over the surface of the granite under the gravel, to reach the lower part of the " forest ".

(*b*) *The Rhigozum trichotomum Veld.*

(See Hutchinson, p. 175.)

This is very similar to the corresponding variation of the Orange River Broken Veld, but has some species which are rare, or not represented at all in that veld, e.g. *Sisyndite spartea*, *Asclepias filiformis*, *Hermannia stricta*, *Leucophrys mesocoma*, *Antizoma* sp. (A. 14260), *Sutera maxii* and *Microloma incanum.*

(*c*) *The Desert False Grassveld.*

In its extreme form, this is a pure grassveld consisting of *Aristida brevifolia*, *A. obtusa*, and *A. ciliata*, with such annuals as *Tribulus terrestris*, *T. zeyheri* and *Schmidtia kalahariensis*, but usually there are a few bushes and dead remains of bushes to show what its real nature is. Towards Goodhouse, for miles, patches of *Aristida brevifolia* are practically all the permanent vegetation. The other two *Aristida* spp. are at a disadvantage in remaining edible when dry and dormant, lacking the woody twigginess of *A. brevifolia.* Indeed, it is said that *A. ciliata* does not really become palatable until its tufts have been dormant for a year or so and become grey and matted; the apt description " blou-dak " is applied to it in this condition.

34. STRANDVELD.

(See Taljaard, Photo 1; Reynolds, Pl. 48; Hutchinson, p. 31.)

This is the vegetation of the lower parts of the sandy western coastal plains, receiving 2–12 inches of rain per annum mainly in winter. It has two variations: (*a*) A dense, dwarf, semi-succulent scrub, related to the Gouritz River Scrub; (*b*) the Strandveld proper, an open, semi-succulent scrub of Fynbos form and intermediate between the Coastal Fynbos and the Succulent Karoo. Bush clumps occur on the hillocks or " heuweltjies ".

(*a*) *Dense Strandveld Scrub.*

One good sample of this scrub has been studied at Yzerfontein. Here it is about four feet high and very dense, a lilliputian forest; but it is generally shorter and more open. Outliers and traces of it occur along the south coast as far as the Sundays River mouth.

The principal species include:—

Rhus glauca.
Euclea racemosa.
Zygophyllum morgsana.
Euphorbia burmannii.
E. mauritanica.
E. marlothiana.
Senecio sp. (A. 14513).
Pteronia divaricata.
P. onobromoides.
Polygala myrtifolia.
Pterocelastrus tricuspidatus.
Cotyledon paniculata.
Limonium roseum.
Asparagus medeoloides.
A. fasciculatus.
A. falcatus.
A. retrofractus.
Pelargonium fulgidum.
P. gibbosum.
Aloe mitriformis.
Putterlickia pyracantha.
Ruschia macowanii.
R. decurvans.
R. bipapillata.
R. utilis.
Solanum guineense.
Lycium sp.
Salvia aurea.
Cynanchum ellipticum.
Lebeckia spinescens forma.
Chrysanthemoides monilifera.
Tetragonia spicata ↓ .
Agropyron distichum ↓ .
Eragrostis cyperoides ↓ ,
Pteronia ovalifolia.
Euclea tomentosa.
Thesium spinosum.
Rhus mucronata.

A patch of this scrub may be seen on the west coast of the Cape Peninsula between Witsand and Scarborough, but less xerophytic and transitional to Dune Forest. The dominants here are *Sideroxylon inerme*, *Maurocenia frangularia*, *Myrsine africana*, *Gymnosporia buxifolia*, *Tarchonanthus camphoratus*, *Rhus glauca*, *Olea foveolata* and *Gymnosporia laurina*, very dense and stunted, and matted together with profusion of *Cynanchum ellipticum*, *Dolichos gibbosus*, *Tetragonia spicata*, *Cussonia thyrsiflora*, *Pelargonium gibbosum*, *Asparagus falcatus* and *Solanum guineense*, with *Ruschia* sp. plentiful at the lower margin.

(*b*) *Strandveld Proper.*

This is a more open scrub, rather clumpy, including the following species:—

Salvia nivea.
S. aurea.
Zygophyllum morgsana.
Ruschia utilis.
R. langebaanensis and others.
Lebeckia spinescens forma.
Pteronia divaricata.
Lycium afrum.
Euphorbia burmannii.
Justicia orchioides.
Galenia africana.
Wiborgia armata.
W. obcordata.
Aspalathus suffruticosa.
Hermannia trifurcata.
Mundia spinosa.
Eriocephalus racemosus.
Willdenowia striata

with species of the dense scrub in the bush clumps and on rocky outcrops, and a variety of smaller bushes, annuals and grasses in the spaces between the larger shrubs, e.g.:—

Grielum tenuifolium.
Helichrysum tricostatum.
Hermannia candicans.
H. scoparia.

Chaetobromus dregeanus.
Ehrharta villosa.
E. calycina.
Galenia africana.
Zygophyllum spinosum.
Manochlamys albicans.
Manulea laxa.
Thesium spinosum.
Mesems.

and many more.

The grasses become plentiful if given a chance, as in the Nortier Reserve, near Lamberts Bay, or at Britannia Bay. The dunes at the latter place are particularly grassy, having also *Schismus barbatus*.

Willdenowia striata becomes plentiful near the upper margin of this veld, providing an easy transition to Arid Fynbos; while towards the lower margin an increase in the proportion of Mesems causes it to pass easily into Succulent Karoo.

IVA.—FALSE KAROO TYPES.

There is no point in burdening this preliminary paper with lists of the species occurring in these veld types, because they would merely be repetitions of the lists given in describing the corresponding genuine veld types. They will be fully described later, when the Relative Abundance Tables have been worked out, and quantitative differences established.

35. FALSE ARID KAROO.

As has been pointed out (p. 92) the whole of the Central Upper Karoo is more or less invaded by elements of the Arid Karoo; but in the part of the original Central Upper Karoo separated as False Arid Karoo, this invasion is so complete that the veld is little different from Arid Karoo, except that it retains many of its own species. The False Arid Karoo lies mainly below 4,000 feet. Much of it has suffered through sheet erosion, but there are some better preserved parts, e.g. between Hopetown and Prieska, whose grassines gives some idea of what the natural condition of the Central Upper Karoo was. The dominant grass, however, is now *Aristida obtusa*, instead of *Eragrostis lehmanniana* and its associates.

The plants which are considered to belong to the Arid Karoo, and to be, therefore, invaders in this region, are the following:—

Pentzia spinescens.
Aristida obtusa.
A. ciliata.
Aptosimum leucorrhizum.
A. abietinum.
A. steingroeveri.
Ruschia ferox.
Zygophyllum microphyllum.
Hermannia spinosa.
Salsola tuberculata.
Pteronia mucronata.
Monechma desertorum.
Phaeoptilum spinosum.
Eriocephalus spinescens.
Monechma incanum.
Aizoon canariense and other annuals.

It must be remembered that many of these species may always have existed in the Central Upper Karoo, but in a subordinate position; so that the word "invade" may partly mean "thicken-up".

The power these Arid Karoo plants have of resisting conditions which hold the Central Upper Karoo species in a dormant state, has been well demonstrated this Spring in the Hofmeyr–Middelburg–Naauwpoort–Hanover area, i.e. not merely in the relatively dry Central Upper Karoo region, but actually in the wetter False Karoo region. This season (1951), this region has had two showers since May: about half an inch in September (promptly dried up by hot, dry winds), and two inches in October, an effective rain, which caused growth to start and the veld to green up. Instead of more rain, however, we have had almost continuous strong winds from the north-west and west, hot and dry; coming not in August, the traditional month for them, but in the hot months of October, November and even December. In consequence, the grasses and karoo bushes did not come into flower, and now are completely shrivelled up and dormant again. On the other hand, those species of the Arid Karoo which have penetrated into these parts, e.g. *Aristida obtusa*, *Asaemia axillaris* and *Aptosimum marlothii*, are flourishing and in full flower, as are the Mesems—from their point of view, conditions are more or less normal.

The western boundary of the False Arid Karoo is clearly defined—west of it, the plants of the Central Upper Karoo are confined to the hills; but the eastern boundary is not clearly defined, the Arid Karoo elements merely becoming gradually less prominent and the veld more typically Central Upper Karoo.

36. False Upper Karoo.

The development of this veld type constitutes the most spectacular of all the changes in the vegetation of South Africa. The conversion of 20,000 square miles of grassveld into eroded Karoo can only be regarded as a national disaster.

This veld, as regards the plains, scarcely differs in appearance from the Central Upper Karoo, except that it has more grassiness, mainly *Aristida curvata*, *A. barbicollis* and *Eragrostis lehmanniana*, especially in the eastern part of it. It is probable that the original grassveld extended as far west as the western watershed of the Seacow River, i.e. roughly a line through Murraysburg, Richmond and Petrusville, the country westwards to the boundary shown on the map, being transitional, predominantly grassy, but fluctuating towards the Karoo condition during droughts. At no time can steekgras be visualized as the dominant grass under natural conditions.

In detail, however, there are differences. In the False Karoo it will be found that:—

> The hills are still essentially of grassveld type and complete grassveld occurs in protected places.
>
> The principal shrub on the hills is *Rhus erosa*, which does not occur in the Central Upper Karoo, even on grassy hills, but does extend north-eastwards into the grassveld as far as Bethlehem.
>
> A grass of general occurrence, though now rare, is *Tetrachne dregei*, also not occurring in the Central Upper Karoo, but extending far into wetter regions to the north and east.

The farmer who introduced Merino sheep into the Colesberg division in the middle of the last century has given us a description of how the sheep converted the sweet grassveld of the country between the Sneeuwberg and the Orange River into eroded Karoo. Unfortunately he does not name the grasses, but he does call this area " one of the prime sheep-walks of the Colony ", so it can hardly have been the sea of *Aristida* and *Eragrostis* which appears after a good rainy season to-day.

Early travellers speak of the complete absence of firewood in this region, but even the botanists among them are vague about the botanical composition of the vegetation. To these early travellers, however, the Karoo was the Little Karoo and Great Karoo; they did not count the Upper Plateau as Karoo.

Schulze has shown that along the western boundary of the False Karoo there is a change in climate from tropical to temperate.

The False Karoo is to-day still advancing into grassveld, and that of a much wetter type than the grassveld with which we are dealing. The pioneer of the False Karoo is *Chrysocoma tenuifolia.*

The south-eastern portion of the False Karoo, in the basin of the Upper Great Fish River and its tributaries, is somewhat different from the rest, being involved also in an invasion of Lower Central Karoo up the Great Fish River valley, so that there is a higher proportion of succulents in the False Karoo here, with *Pentzia incana* the dominant karoo bush instead of *P. globosa.*

The False Karoo types are inclined to be sparser than the genuine Karoo types, especially near their upper margins, because, until the grassveld soil has eroded away, the Karoo has no secure foothold. It cannot protect the soil from erosion and does not need it; so only when the harder subsoil or the bare rock has been exposed, does the invading Karoo feel happy, and only then does the full mixture of Karoo species come in. In this marginal grassveld zone the activities of the large population of Harvester termites becomes conspicuous when the grass-cover becomes insufficient to supply the needs of the termites as well as the needs of the grazing animal. Killing the termites will not restore the grass unless enlightened veld management is practised at the same time.

To a smaller extent than the Central Upper Karoo, this veld type has been invaded by elements of the Arid Karoo, almost to its eastern limits, but they are inclined to be sensitive as regards habitat. Thus *Aristida obtusa*, which might be valuable in covering up the bare soil, only grows in places where there is a layer of sand over calcareous tufa, in cases where *Eragrostis bergiana* is not already in possession. In passing, it may be pointed out that, around Middelburg, *Eragrostis bergiana* in such habitats will grow so densely as to have a basal cover of 60 per cent. The leaves are so short, however, that it can only be grazed when the ends of the stolons curl up off the ground during a drought.

37. FALSE KARROID BROKEN VELD.

(See Reynolds, Pl. 29; White, Dyer and Sloane, Fig. 398.)

This veld type much resembles the Great Karoo form of the Karroid Broken Veld, but, occurring in a less arid region, is taller, denser and slightly less desertlike; but it has more than one origin.

(1) From Aberdeen to Bruintjieshoogte along the foot of the mountains, and up the Great Fish River valley to Cradock, it is probably the result of invasion, by Central Lower Karoo and Karroid Broken Veld, of an open grassy shrub savannah marginal to the Spekboomveld and scrub of the lower mountain slopes, accompanied by destruction of the grass cover and soil erosion. A similar process can still be seen going on on the lower northern slopes of these same mountains.

(2) In the lower part of the Upper Great Fish River basin, north of Cradock, it is probably the result of spread of elements of the open, grassy Karroid Broken Veld scrub of the mountains and of invasion by Central Lower Karoo, into grassveld of Dry *Cymbopogon–Themeda*-veld type, accompanied by the grazing out and eroding out of the grassveld.

(3) In this same region (on steep mountain sides), and down the valleys of the Great Fish River and its tributaries towards Grahamstown, it is the result of thinning out or destruction of Valley Bushveld, Spekboomveld and Fish River scrub, eating out of the grassveld associated with these veld

types, erosion, and invasion by Central Lower Karoo. The sudden destruction of the prickly pear in recent years has given it a further chance to spread.

(4) Along the foot of the mountains from Somerset East to Debe Nek, and in the basin of the Upper Black Kei, we can see the beginnings of another method of development of False Karroid Broken Veld—*Acacia karoo* invades from the south and east, Central Lower Karoo and Central Upper Karoo invade from the west, and both contribute towards the destruction of the grassveld. As has been pointed out above (p. 15), a similar danger exists in the western parts of the Orange Free State and Transvaal.

(5) Although distinctive enough to be kept as a separate veld type, the result of invasion of Kalahari Thornveld and Vryburg Shrub Bushveld by Karoo is also, of course, Karroid Broken Veld.

(6) There are signs, in the Middelburg area, that *Acacia karroo* is spreading into the False Karoo of the upper plateau; the result of such a spread would also be False Karroid Broken Veld. A distinctive species of the False Karroid Broken Veld of the Eastern Cape is *Becium burchellianum.*

38. FALSE CENTRAL LOWER KAROO.

This veld type is of limited area, occurring in the lower and flatter parts of the shallow valleys below the mountains from Aberdeen to Adelaide, in that zone which is visualized as having been marginal grassveld or shrub-savannah. It differs from the False Karroid Broken Veld in lacking trees and shrubs, and lacks the short denseness of the genuine Central Lower Karoo, but has the same species.

39. FALSE SUCCULENT KAROO.

This is a somewhat vague type, because, as has been pointed out already (p. 14), the country where it occurs is hardly suitable for it, so that it is inclined to be desert, sparsely populated with Mesems. and relicts of the Arid Karoo. Seeing that the reason for its development is excessive grazing pressure, the species that are of value for grazing will be precisely the ones that do not appear in it. This phenomenon is of general application to all the "False" veld types.

These are the names of such species as have been determined; there are many more, especially in the stony wilderness to the east and south-east of the Kamiesberg:—

Ruschia robusta.
R. ferox.
R. muricata.
R. leucanthera.
R. leucosperma.
R. kakamasensis.
R. uncinella.
R. sp. = A. 15062.
Brownanthus ciliatus.
Psilocaulon absimile.
P. arenosum.
Aridaria suffusa.
A. tetragona.
A. sp. § Noctiflora.
Hereroa fimbriata.
Drosanthemum framesii.
Herrea nelii var.

Ruschia robusta is the most important, covering miles and miles of gravelly country. Another important succulent at times is the annual *Augea capensis.*

It is possible that much of the Steytlerville Karoo should be counted as False Succulent Karoo, but this veld type requires more study.

40. False Orange River Broken Veld.

In the Orange River valley and the Strydenburg area, this takes the form of the development of thickets of *Acacia detinens* and *Rhigozum trichotomum*, with a little *Phaeoptilum spinosum*, *Boscia albitrunca*, *Cadaba juncea* and stunted *Acacia heteracantha* in False Arid Karoo. In valleys and on silty flats, *Aridaria tetragona* and *Psilocaulon absimile* become abundant.

In the Vaal River valley, it takes the form of invasion of the Vryburg scrub bushveld by *Acacia detinens* and *A. heteracantha* often forming thickets, with more or less of the Karoo constituent of the Orange River Broken Veld. Similar patches of False Orange River Broken Veld are developing on a small scale on limestone outcrops in the valleys between the Kuruman Hills and the Langeberg, at least as far north as Kathu.

41. Pan Turf Veld Invaded by Karoo.

Where the turfy soil still covers the calcareous tufa, the vegetation is inclined to become very sparse and stunted, at least as regards perennials. It consists mainly of:—

Enneapogon brachystachyus.
Eragrostis bicolor.
Cyperus usitatus.
Aster muricatus.
Nestlera conferta.
Asparagus sp. (stiff glaucous)
Lycium oxycladum (dwarf).
Pentzia globosa.
Sporobolus tenellus.
Salsola humifusa.
S. glabrescens.

sometimes with abundance of the annuals *Aristida curvata*, *Chloris virgata*, *Tragus berteronianus*, *Tribulus terrestris*, *Brachiaria marlothii* and *Sporobolus argutus*. As the floors of the pans dry up after being flooded, *Diplachne fusca* sometimes covers them with a sheet of green; no doubt the original vegetation of the pans was a permanent *Echinochloa holubii* veld, of which *Diplachne fusca* was a constituent.

But where the calcareous tufa is exposed, the False Karoo is much more complete, often with relicts of *Themeda*, and sometimes with a dense mat of *Eragrostis bergiana* and *Tragus koelerioides* as in the False Karoo of the Naauwpoort–Middelburg–Hofmeyr area; thus it is quite a good karoo veld with:—

Eragrostis bergiana.
Sporobolus ludwigii.
S. tenellus.
S. usitatus.
Cyperus usitatus.
Aster muricatus.
Eragrostis lehmanniana.
Themeda triandra.
Blepharis integrifolia.
Pentzia virgata.
P. globosa.
Nestlera conferta.
Nenax microphylla.
Tragus koeleriodes.
Stachys spathulata.
Fingerhuthia africana.
Berkheya annectens.
Geigeria passerinoides.
Digitaria argyrograpta.
Eragrostis bicolor.
Vahlia capensis.
Aloinopsis sp.
Thesium hystrix.
Urginea pusilla.
Cymbopogon plurinodis.
Arthrosolen polycephalus.
Lycium oxycladum (dwarf).
Heliotropium nelsoni.
Justicia orchioides.
Panicum coloratum.
Falkia oblonga.

and many more.

It is suspected that further study will show that a good deal of the False Karoo in the southern part of the Orange Free State, west of the

Reddersburg–Bloemfontein Road, would better be included in this veld type, or a variation of it, likewise the flood plains in the Middelburg area

42. Karroid Danthonia Mountain Veld Replaced by Karoo.

This veld type occurs on the mountains north of Beaufort West and on the mountains between Murraysburg and Somerset East and Cradock; actually, it could well have been shown as occurring around the margin of nearly all the Karroid Danthonia Mountain Veld. It tends to develop mainly in the valleys, where grazing is heaviest and most continuous; but in the case of some of the lower mountains it has reached the top, where it becomes semi-succulent, with bushy Ruschia spp.

At its lower margin, it is indistinguishable from ordinary False Upper Karoo (or False Central Lower Karoo on the south side of the mountains), except for occasional tufts of *Danthonia disticha* and relicts of complete Karroid Danthonia Mountain Veld on well cared for farms. At higher levels, however, it has some distinctive features, tending to be tall and becoming transitional to the False Karroid Rhenosterbosveld (p. 141) which has invaded so much of the higher parts of the Karroid Danthonia Mountain Veld; here it represents the Western Mountain Karoo of more arid regions westwards, and includes the following species as typical:—

Chrysocoma tenuifolia.
Dimorphotheca cuneata.
Nestlera prostrata.
Walafrida saxatilis.
Selago brevifolia.
Eriocephalus punctulatus.
Pentzia globosa.
P. punctata.
Helichrysum hamulosum.
Selago albida.
Aster filifolius.
Pteronia tricephala.
P. glauca.
Lightfootia albens.
Euryops oligoglossus.
Passerina montana.
Elytropappus rhinocerotis l.

and many more.

Usually there are relicts of *Danthonia disticha*, *Themeda triandra*, *Cymbopogon plurinodis*, *Aristida diffusa* var. *burkei*, *Eragrostis chloromelas*, *E. lehmanniana*, etc., their abundance depending on the completeness of the replacement of the grassveld by Karoo.

A feature of this veld type is soil erosion, still very actively removing the deep, black vlei soil of the mountain valleys. Here and there, also, one finds patches of soil on the slopes, that give one an idea that the lower slopes, at least, of the False Karoo mountains were formerly covered with soil to considerable depth. As one goes eastwards one can find various stages in the removal of such a mantle of soil, e.g. along the Bamboesrand at the edge of the False Karoo, or along the edge of the White Kei valley between Queenstown and Lady Frere. The loss of this soil is, for practical purposes, irreparable.

43. Mountain Rhenosterbosveld.

As it is shown on the map, this veld type does not include by any means all of the Rhenosterveld occurring on the mountains of the Cape, only that falsely karroid part of it where the rhenosterbos appears to be the natural dominant, or, at least, shows no sign of being an invader into some other veld type. Thus, to-day, a good deal of what is shown as False Fynbos is more or less rhenosterbosveld, and so is much of the Karroid Danthonia Mountain Veld, but in these cases there can be no doubt that the rhenosterbos is an invader. In this small-scale map, therefore, these invasions have been ignored, but they will be described when the veld types which they have invaded are being considered.

The Mountain Rhenosterbosveld is included in the False Karoo types because its former grassiness, of southern type, of which *Danthonia stricta* is the chief relict to-day, has largely been replaced by Karoo. The Coastal Rhenosterbosveld is of different affinity, non-karroid and replacing tropical scrub and grassveld, i.e. it is of higher successional rank, equal to that of the non-karroid rhenosterbosveld which replaces Fynbos.

It may be that the Mountain Rhenosterbosveld, in its original grassy condition, is to the Fynbos what the thornveld is to the tropical forest, and is to the Karoo what the thornveld is to the Valley Bushveld.

The typical species include:—

Elytropappus rhinocerotis.
Relhania squarrosa.
R. genistifolia.
Eriocephalus umbellatus.
Euryops lateriflorus.
Pentzia incana (tall).
Chrysocoma tenuifolia.
Polygala pinifolia.
Helichrysum hamulosum.
Walafrida saxatilis.
W. articulata.
Selago albida.
Phymaspermum sp. (=A. 14642).
Pteronia incana.
Ruschia multiflora.
R. cymosa.
Galenia africana.
Asparagus capensis.
Zygophyllum spinosum.
Aster filifolius.
Dimorphotheca cuneata.
Ehrharta calycina.
Danthonia stricta.
Lasiochloa longifolia.
Cotyledon wallichii (sometimes)
Gnidia nitida.

Around Touws River are some interesting transitions to Fynbos, Western Mountain Karoo and Succulent Karoo.

V.—TEMPERATE AND TRANSITIONAL FOREST AND SCRUB TYPES.

By "temperate forest" is meant the forest of relatively temperate habitats; although it includes a higher proportion of southern species than does the coastal forest, it is still essentially of tropical affinity.

44. (*a*) Highland Sourveld.

(See Marloth I, Pl. 10; III, 2, Fig. 110; Taljaard, Photos 106, 107, 108, 109, 110.)

This is the veld of the eastern slopes and foothills of the Drakensberg from about 4,500–7,000 feet above the sea, extending over the top of the escarpment on to the edge of the Upper Plateau in the lower part of the range between Mont-Aux-Sources and Volksrust. Outliers occur on the Helpmekaar, Qudeni–Babanango and Mahlabatini plateaux at somewhat lower elevations, but these outliers are transitional to the North-Eastern Mountain Sourveld. Rainfall ranges from 30–60 inches per annum, falling in summer; frosts are severe in winter, and snow falls at the higher altitudes. It is rolling country, falling steeply into the numerous valleys, where the vegetation is Tall Grassveld.

It is probable that the whole area was originally forest and scrub-forest, but relicts are few and small, and badly mutilated.

Trees of general occurrence are:—

Leucosidea sericea.......	1,455	Rapanea melanophloeos.	133
Trimeria grandifolia.....	646	Olinia spp.............	131

Heteromorpha trifoliata	558	Scolopia mundtii	102
Podocarpus latifolius	214	Kiggelaria africana	34
Halleria lucida	194		

Trees of less general occurrence are:—

Scolopia flanagani	357	Calodendrum capense	28
Cryptocarya woodii	356	Celtis kraussiana	28
Ptaeroxylon obliquum	247	Podocarpus falcatus	17
Apodytes dimidiata	30	Fagara davyi	13
Pittosporum viridiflorum	29	Gymnosporia acuminata	5

The dominant tree is clearly *Podocarpus latifolius*: the indicators will be this species as dominant with *Canthium ciliatum* dominant in the undergrowth and *Leucosidea sericea* at the margin. *Leucosidea* becomes the dominant, at the upper edge of the veld type, in scrub forest with Fynbos and *Widdringtonia dracomontana.*

Shrubs and climbers of general occurrence are:—

Senecio deltoideus	5,205	Grewia occidentalis	396
Canthium ciliatum	3,616	Buddleja salvifolia	122
Royena lucida	1,553	Myrsine africana	117
Clausena anisata	821	Rhamnus prinoides	115
Scutia myrtina	677	Gymnosporia buxifolia	74
Canthium pauciflorum	554	Cassinopsis ilicifolius	41
Carissa bispinosa	468	Rhus transvaalensis	7
Clematis brachiata	405	Osyridicarpos natalensis	4

Shrubs and climbers of less general occurrence include:—

Asparagus plumosus	959	Gymnosporia rubra	196
Cissampelos torulosa	937	Rubus pinnatus	155
Peddiea africana	711	Calpurnia sylvatica	120
Senecio mikanioides	600	Secamone alpini	52
Gymnosporia harveyana	556	Andrachne ovalis	30
Rhoicissus cuneifolius	382	Sparmannia ricinocarpa	17
Behnia reticulata	233	Dovyalis rhamnoides	12
Strophanthus speciosus	233	Euclea natalensis	4
Senecio tamoides	220	Dais cotinifolia	2

Sometimes *Greyia sutherlandii* and *Aloe arborescens* are conspicuous on krantzes.

Smaller plants of general occurrence are:—

Stipa dregeana var. elongata	7,201	Pteridium aquilinum	2,501
Polystichum luctuosum	3,191	Ehrharta erecta	2,442
Brachypodium flexum	3,125	Argyrolobium tomentosum	1,467
Asparagus virgatus	3,043	Solanum aculeatissimum	34
Galopina circaeoides	2,723		

Of less general occurrence are:—

Cyperus albostriatus	15,831	Schoenoxiphium sparteum var.	1,006
Hypoestes verticillaris	14,464	Galium rotundifolium	907
Australina acuminata	5,701	Cluytia pulchella	870
Oplismenus hirtellus	5,581	Panicum aequinerve	817
Streptocarpus rexii	4,610	Achyranthes aspera	797
Moraea iridioides	4,251		

Other Acanthaceae	3,289	Polygala ohlendorfiana	714
Impatiens duthieae	2,226	Poa binata	512
Asplenium praemorsum	1,078	Pellaea viridis	490
Geranium ornithopodum	1,042	Peperomia reflexa	366

and many more, the total number of species in the Relative Abundance Table being 367.

The grassveld, Highland Sourveld, which replaces this forest, is, in the more level parts, a pure grassveld, lacking the thorns and scrubbiness of warmer types. On the mountain slopes, however, there may be a good deal of scrubbiness, and, in parts, this veld is a savannah of *Protea caffra* and/or *P. rouppelliae.*

Generally occurring species of the Highland Sourveld are:—

Themeda triandra	323,220	Harpechloa falx	7,303
Tristachya hispida	215,900	Eragrostis plana	5,029
Trachypogon capensis	169,617	Hyparrhenia hirta	3,638
Heteropogon contortus	144,789	Aristida junciformis	3,487
Eragrostis chalcantha	135,940	Andropogon amplectens	3,248
Andropogon filifolius	78,768	Acalypha depressinervia	3,008
Monocymbuim ceresiiforme.	43,763	Panicum ecklonii	2,472
		P. natalense	1,786
Rendlia nelsonii	30,632	Hypoxis rigidula	1,033
Alloteropsis semialata var.	29,617	Eulalia villosa	820
		Pentanisia prunelloides	746
Microchloa caffra	27,838	Helichrysum latifolium	722
Eragrostis capensis	10,413	Haplocarpha scaposa	243

Of less general occurrence are:—

Elyonurus argenteus	10,927	Sporobolus centrifugus	1,100
Ficinia spp	6,715	Oldenlandia amatymbica	1,009
Digitaria monodactyla	3,837	Indigofera hilaris	928
Andropogon appendiculatus	2,730	Helichrysum rugulosum	888
		Eriosema kraussianum	828
Brachiaria serrata	2,440	Helichrysum simillimum	766
Andropogon schirensis	1,954	H. aureo-nitens	721
Bulbostylis sp	1,690		

and many more, the total number of species in the Relative Abundance Table being 171.

This veld is easily reduced to *Eragrostis plana* by trampling and selective grazing by cattle, while in veld overgrazed by sheep, *Acalypha depressinervia* tends to dominate. Much work has been done on the reactions of this veld to grazing management at Tabamhlope Research Station. It is capable of intensification, but, with its dry, frosty winters, hail storms in summer, deep but leached soils and short growing season, it is difficult country for farming.

(*b*) The Dohne Sourveld.

This veld type is generally very similar to the Highland Sourveld, but lies at lower altitudes, 2,000–4,500 above sea-level, is warmer, and drier, receiving 25–40 inches of rain per annum, and no snow in winter except on the tops of the mountains. Soils are less thoroughly leached, in the drier parts having an erodible subsoil at no great depth, so that soil erosion is more in evidence than in the Highland Sourveld, though generally occurring only as single dongas or systems of dongas. Relicts of forest are more numerous, larger and better preserved (the succession to forest being stronger in this less frosty region), especially south-westwards on the Amatolas and other mountains to Somerset East. Some of these mountains are still covered with forest from top to bottom, though much of it has been reduced to scrub forest.

Trees of general occurence are:—

Trichocladus ellipticus	1,355
Halleria lucida	592
Trimeria grandifolia	430
Podocarpus falcatus	231
P. latifolius	175
Rhus legati	174
Rapanea melanophloeos	130
Scolopia mundtii	81
Vepris lanceolata	75
Pittosporum viridiflorum	69
Olea laurifolia	68
Canthium ventosum	61
Celtis kraussiana	52
Curtisia faginea	50
Xymalos monospora	27
Kiggelaria africana	19
Olea foveolata	18
Calodendron capense	15
Heteromorpha trifoliata	11
Gymnosporia peduncularis	9
Cussonia spicata	8
Scolopia ecklonii	8
Ilex mitis	7

Trees of less general occurrence include:—

Dovyalis spp.	283
Apodytes dimidiata	30
Ptaeroxylon obliquum	24
Scolopia flanagani	23
Allophylus decipiens	21
Pleurostylia capensis	16
Leucosidea sericea	16
Cassine papillosa	13
Pterocelastrus tricuspidatus	11
Hippobromus pauciflorus	10
Podocarpus henkelii (northwards)	7
Gymnosporia acuminata	7

Shrubs and climbers of general occurrence are:—

Canthium ciliatum	2,875
Scutia myrtina	2,606
Behnia reticulata	1,940
Cissampelos torulosa	1,854
Grewia occidentalis	1,774
Rhoicissus cuneifolius	1,602
Calpurnia sylvatica	1,511
Royena cordata	743
Senecio deltoideus	715
Carissa bispinosa	583
Secamone alpini	582
Gymnosporia buxifolia	580
Asparagus plumosus	474
Strophanthus speciosus	385
Gymnosporia harveyana	342
Royena lucida	95
Cassinopsis ilicifolius	81
Fagara capensis	53
Rhamnus prinoides	26
Burchellia bubalina	14

Shrubs and climbers of less general occurrence in the Dohne Sourveld forests include:—

Gardenia neuberia	559
Senecio tamoides	376
Andrachne ovalis	330
Canthium pauciflorum	288
Royena villosa	256
Maesa alnifolia	183
Secamone frutescens	164
Senecio mikanioides	157
Dalbergia obovata	156
Pavetta kotzei	118
Eugenia zuluensis	81
Grewia lasiocarpa	81
Rhoicissus digitata	81
Cnestis natalensis	78

and many more.

Species in the undergrowth of general occurrence are:—

Oplismenus hirtellus	20,275
Stipa dregeana var. elongata	17,411
Centella coriacea	14,116
Moraea iridioides	4,072
Polystichum luctuosum	2,531
Polypodium polypodioides	2,097

Galopina circaeoides....	7,279	Streptocarpus rexii......	1,950
Cyperus albostriatus....	6,378	Cymbopogon validus....	924
Ehrharta erecta.........	6,258	Cluytia pulchella........	382

Of less general occurrence in the undergrowth are:—

Hypoestes verticillaris...	25,916	Peperomia reflexa.......	1,214
Other Acanthaceae......	15,578	Asparagus virgatus......	1,183
Sanicula europaea.......	9,289	Plectranthus laxiflorus...	1,148
Stachys aethiopica.......	4,023	Asplenium praemorsum.	984
Fleurya mitis...........	2,467	Schoenoxiphium sparteum	804
Hypolepis bergiana......	2,224	Plectranthus ecklonii....	736
Argyrolobium tomentosum	1,977	Polygala ohlendorfiana..	677
Selaginella kraussiana...	1,354		

and many more, the total number of species in the Relative Abundance Table being 468.

This forest has far more climbers and is richer in species than the forest of the Highland Sourveld. *Podocarpus falcatus* is here the dominant, but *P. latifolius* is still almost as numerous as in the Highland Sourveld forests; so the indicators will be *Podocarpus falcatus* and *P. latifolius* as dominants, with *Canthium ciliatum* and *Trichocladus ellipticus* in the undergrowth. This complete dominance of *Podocarpus* at once distinguishes these forests from those previously described and justifies the name " Temperate Forests."

This forest further resembles the Highland Sourveld forest, especially on the mountains from the Amatolas westwards, in being associated with Fynbos. The Fynbos occurs on rocky outcrops on the grassy mountain tops and at the forest margin, particularly the upper margin. It includes such species as:—

Protea lacticolor.
Widdringtonia sp.
Aspalathus microdon.
Myrica brevifolia.
Arrowsmithia styphelioides.
Phylica simii.
Struthiola parviflora.
Macowania revoluta.
Stoebe vulgaris.
Pelargonium cordatum.
Cliffortia linearifolia.
C. paucistaminea.
Erica brownleeae.
E. caffra.
Anthospermum aethiopicum.
Metalasia muricata.
Agathosma ovata.

and others.

It is thus a more complete Fynbos than that of the Drakensberg.

The Dohne Sourveld which replaces this forest is also a dense, sour grassveld. At Dohne Research Station, average basal cover is 30 per cent, ranging from abour 18 per cent to 40 per cent, according to grazing treatment. Species of general occurence are:—

Themeda triandra......	537,723	Microchloa caffra......	26,395
Heteropogon contortus.	373,877	Senecio retrorsus......	10,121
Tristachya hispida......	261,200	Harpechloa falx.......	7,818
Eragrostis capensis.....	144,042	Eragrostis plana.......	3,100
Sporobolus capensis....	48,652	Brachiaria serrata......	1,952
Elyonurus argenteus....	28,942	Rhynchosia totta......	1,666

Species of less general occurrence in the Dohne Sourveld include:—

Eragrostis chalcantha....	15,552	Eulalia villosa..........	4,517
Trachypogon capensis...	11,484	Cyperus compactus var. flavissimus	3,067
Eragrostis chloromelas...	11,054		

Setaria nigrirostris	8,782	Anthospermum sp.	2,607
Digitaria monodactyla	8,521	Hypoxis argentea	1,878
Ficinia spp.	6,163	Alloteropsis semialata var	1,464
Andropogon appendiculatus	5,077	Sporobolus centrifugus	1,201

and many more, the total number of species in the Relative Abundance Table being 255.

This veld type shows a good deal of variation. North of the Umzimvubu River it merges into the Pondoland Plateau Sourveld; in sandy valleys in the Mount Fletcher area it is sparser, with a good deal of *Aristida junciformis*, while in its westward extension to the Katberg, Winterberg and Boschberg, it is transitional to the wetter upper margin of the Karroid Danthonia Mountain Veld, with abundance of *Bromus firmior*, *Festuca longipes*, *F. costata*, *Tetraria cuspidata*, *Lasiochloa longifolia*, *Danthonia curva*, *Pennisetum sphacelatum* and *Helictotrichon* spp., although the usual species are still the dominants. That is to say, the grassveld, like the forest, has a strong southern element.

Mismanagement of this veld by selective grazing encourages *Elyonurus argenteus* rather than *Eragrostis plana*, and, at lower altitudes, brings in such an abundance of *Senecio retrorsus* that it attracts visitors from neighbouring districts to see it flowering. Counts have shown that in a bad infestation there may be 500,000 or more plants of *Senecio* per morgen. A characteristic plant of disturbed soil is the big bushy *Senecio pterophorus*. At higher altitudes, on the Amatola mountains overgrazing has other effects: sometimes it causes *Helichrysum argyrophyllum* to invade and ultimately replace the grassveld, whitening the shoulders of the mountains; sometimes it causes a False Fynbos, composed of elements of the local Fynbos relicts, to invade the grassveld. The important species concerned in this invasion are *Cliffortia linearifolia*, *C. paucistaminea* and *Erica brownleae*. A thorough study of the area has been made by Story (1952).

45. Natal Mist Belt ’Ngongoni Veld.

(See Taljaard, Photo 115.)

This is a transitional type between the ’Ngongoni Veld and the Highland Sourveld, lying at altitudes ranging from 3,000–4,500 feet above the sea, and receiving 35–45 inches of rain per annum. It is misty country, which gives it an agriculturally more favourable climate than the Highland Sourveld and makes it well suited for intensive farming.

Little of the forest survives, except at the upper margin of the veld type where *Podocarpus* spp. are the dominants, but at lower levels they are scarcer. The coastal forest element is so strong, however, that it might have been better to group it with the ’Ngongoni Veld.

The trees of general occurence are:—

Rapanea melanophloeos	2,025	Vepris lanceolata	14
Cryptocarya woodii	1,882	Celtis kraussiana	9
Syzygium gerrardii	1,882	Ficus natalensis	9
Combretum kraussii	210	Kiggelaria africana	9
Xymalos monospora	127	Podocarpus falcatus	8
Halleria lucida	119	P. latifolius	8
Pittosporum viridiflorum	100	Calodendron capense	5
Trimeria grandifolia	89	Cussonia spicata	5
Cassipourea verticillata	83	Trema guineensis	5

Fagara davyi	14	Canthium mundianum	1
Rhus legati	14	Cussonia umbellifera	1

Trees of less general occurrence are scarce, they include:—

Leucosidea sericea	6	Olinia spp	2
Cunonia capensis	3	Podocarpus henkelii	2
Alberta magna	2	Protorhus longifolia	2
Allophylus melanocarpus	2	Ptaeroxylon obliquum	2
Ficus craterostoma	2	Pygeum africanum	2
Gymnosporia acuminata	2	Scolopia mundtii	2

Shrubs and climbers of general occurrence include:—

Dalbergia obovata	3,825	Tricalysia lanceolata	313
Uvaria caffra	2,500	Peddiea africana	218
Cassinopsis ilicifolius	1,375	Clausena anisata	210
Strophanthus speciosus	1,300	Maesa lanceolata	130
Behnia reticulata	1,255	Entada spicata	130
Allophylus monophyllus	1,013	Secamone alpini	100
Gymnosporia harveyana	834	Burchellia bubalina	89
Carissa bispinosa	743	Canthium ciliatum	89
Scutia myrtina	644	Rhoicissus capensis	89
Canthium gueinzii	482	Cissampelos torulosa	82
Grewia occidentalis	476	Rhoicissus rhomboideus	82
Euclea natalensis	313		

and many more.

Shrubs and climbers of less general occurrence include:—

Senecio deltoideus	1,250	Choristylis rhamnoides	63
Dioscorea dregeana	625	Myrica sp	63
Jasminum stenolobum	625	Senecio tamoides	55
Dioscorea cotinifolia	363	Rubus cuneifolius	36

In the undergrowth, the species of general occurrence are:—

Oplismenus hirtellus	85,050	Moraea iridioides	2,138
Cyperus albostriatus	18,340	Pteris biaurita	2,081
Galopina circaeoides	11,700	Potamophila prehensilis	2,025
Selaginella kraussiana	8,625	Argyrolobium tomentosum	1,563
Plectranthus laxiflorus	7,325		
Sanicula europaea	5,750	Carex spicato-paniculata	1,375
Hyparrhenia sp	4,680	Blechnum attenuatum	1,322
Panicum aequinerve	4,505	Leonotis leonurus	130
Polystichum luctuosum	3,938	Oldenlandia natalensis	130
Asparagus virgatus	2,709	Euphorbia kraussiana	85
Pteridium aquilinum	2,348	Impatiens duthieae	25

while the following are of less general occurrence:—

Hypoestes verticillaris	22,500	Achyranthes aspera	1,300
Australina acuminata	7,205	Chlorophytum sp	625
Dicliptera quintasii	5,625	Asplenium praemorsum	625

and many more, the total number of species in the Relative Abundance Table being 216.

The grassveld which replaces this forest is a definitely *Themeda*-dominated sourveld, relatively sparse, and to-day largely replaced by *Aristida junciformis*. Species of general occurrence are:—

Themeda triandra	489,600	Eragrostis curvula	8,364
Monocymbium ceresiiforme	53,911	Alloteropsis semialata var.	4,444
Trachypogon capensis	40,067	Andropogon schirensis	3,337
Tristachya hispida	30,836	Eragrostis capensis	2,311
Aristida junciformis	23,032	Hyparrhenia hirta	1,793
Eragrostis chalcantha	20,311	Eragrostis plana	170
Heteropogon contortus	18,778	Digitaria tricholaenoides	70
Andropogon filifolius	15,022	Spermacoce natalensis	39
Brachiaria serrata	10,433		

Species of less general occurrence include:—

Rendlia nelsonii	3,756	Pteridium aquilinum	1,111
Digitaria diagonalis	1,111	Setaria nigrirostris	876
Hypoxis rigidula	1,111	S. sphacelata	642
Loudetia simplex	1,111	Andropogon amplectens	558
Microchloa caffra	1,111	Helichrysum rugulosum	558

and many more, the total number of species in the Relative Abundance Table being 102.

Much of this region has been planted to exotic *Acacia* spp. and *Eucalyptus* spp., while another exotic, *Rubus cuneifolius*, is tending to spread into the grassveld.

46. COASTAL RHENOSTERBOSVELD.

This occurs in two blocks, one on the west coastal plain, undulating country, one on the south coastal plain, rolling country. In either case the soil is clayey and has been so completely ploughed up for growing wheat that relicts of the natural vegetation are scarce and in poor condition. Altitude ranges from 0–1,000 feet and rainfall from 12–20 inches per annum, falling in winter in the western block, mainly in winter, but partly in summer in the southern block, especially south of Swellendam.

The natural vegetation appears to have been scrub, perhaps, judging by relicts, very dense and thorny, with *Olea africana* and *Sideroxylon inerme* the dominants. The lower part of the valleys in the southern block may have had a drier, semi-succulent scrub, in which *Acacia karroo*, *Aloe arborescens* and *Aloe ferox* were conspicuous; while the upper part of the valleys appears to have had a scrub forest transitional to the forest of the Langeberg.

The following species still occur in the southern coastal belt:—

Cussonia spicata W l.
Buddleja salicifolia W l.
Rhus lucida W l.
Grewia occidentalis W l.
Royena decidua W l.
Olea africana.
O. exasperata.
Sideroxylon inerme.
Gymnosporia buxifolia.
Rhus longispina.
R. glauca.
Azima tetracantha.
Carissa haematocarpa.
Pterocelastrus tricuspidatus.
Cassine tetragona var. laxa.
Euclea racemosa.
E. undulata.
Chrysanthemoides monilifera.
Euphorbia rectirama.
E. clandestina.
Osyris compressa.
Acacia karroo.
Myrsine africana.
Rhyticarpus difformis.

Gymnosporia capitata.
Sarcostemma viminale.
Aloe ferox.
Asparagus multiflorus.
Aloe saponaria.
Salvia aurea.
Ehrharta aphylla.
Danthonia disticha.

i.e. a fairly complete scrub, related to the Gouritz River Scrub, but less succulent.

The only relict of the valley scrub of the rivers west of the Gouritz that has been seen, occurs on a small krantz in the Salt River valley on the Bredasdorp–Malagas Road. Here is the list made there:—

Aloe ferox F.
Pteronia sp. F.
Mesems, 2 spp. F.
Ruschia sp. cf. R. hamata f.
Crassula lycopodioides f.
Asparagus falcatus f.
Relhania squarrosa f.
Carissa haematocarpa f.
Rhus glauca lF.
Pteronia incana lF.
Asparagus burchellii lf.
Sideroxylon inerme O.
Gymnosporia laurina r.
Zygophyllum morgsana lFF.
Euphorbia burmannii lFF.
E. mauritanica o.
Cassine tetragona var. laxa rt.
Asparagus kraussii o.
A. medeoloides ot.

etc., with *Acacia karroo*, F; *Buddleja salicifolia* FF; *Atriplex halimus* C; *Melianthus major* ff, *Conyza ivaefolia* ff on the river banks, and *Salicornia fruticosa*, *S. natalensis*, *Sporobolus pungens* and Mesems on saline flats. This is a damaged relict but will serve to show that the Gouritz River Scrub, or something like it, occurred westwards in the valleys when the south coast belt was still covered with scrub, rather than the Little Karoo type of scrub which occurs in the Sondereinde River valley and in the Breede River valley around Bonnievale.

In the west coast belt, no good relicts of the scrub have been seen, but there are indications, e.g. on the granite southern slopes of the Kanonberg, near Brackenfel Station, that it might have been more succulent and related to the Strandveld Scrub.

The Rhenosterbosveld which has replaced the scrub where the soil is not cultivated, is predominantly rhenosterbos, with more or less of the following:—

Relhania squarrosa.
R. genistifolia.
Selago corymbosa.
S. fruticosa.
Chrysanthemum carnosulum.
Helichrysum sp.cf.H. anomalum.
Ruschia hamata.
Aspalathus laricifolia.
Osteospermum imbricatum.
Dicoma spinosa.
Athanasia trifurcata.
A. linifolia.
Muraltia thymifolia.
M. filiformis.
Polygala oppositifolia (sometimes C).
P. garcini.
P. affinis.
Hermannia flammea.
H. (M. ovalis) and others.
Senecio pubigerus.
Chrysocoma tenuifolia.
Gnidia polystachya.

There is often much grass too, which, in protected places at the edge of lands, or in stony places which can never have been ploughed, is an extremely dense sward of *Themeda triandra*. *Themeda* is scattered through the Rhenosterbosveld, too, together with:—

Ehrharta sp.
E. calycina.
Lasiochloa longifolia.
Aristida diffusa var. burkei.

Danthonia disticha.
D. stricta.
D. lanata and others.
Cymbopogon plurinodis.
Hyparrhenia hirta.
Plagiochloa sp.
Brachiaria serrata.

Eragrostis capensis.
E. curvula.
Koeleria cristata.
Festuca scabra.
Danthonia purpurea (A. 15456).
Sporobolus capensis.
Helictotrichon capense.

At the upper margin of the south coastal Rhenosterbosveld, where it becomes transitional to False Fynbos and Coastal Fynbos, the sourveld grasses *Trachypogon*, *Heteropogon*, *Aristida junciformis* and *A. capensis* come in. Within the National Road enclosure between Mossel Bay and Swellendam, it is instructive to note how the grassveld is becoming dominant, the Fynbos becoming reduced to the status of forbs and *Elytropappus* suppressed. It will be interesting to see how long the scrub takes to start regenerating.

The Rhenosterbosveld of the west coast belt is somewhat different, with an admixture of Fynbos and less grass. Such differences are due to the winter rainfall. At its lower margin it becomes semi-succulent and merges easily into the Strandveld. Little information is available about it.

47. Coastal Macchia.

This occurs on sand and limestone in the west and south coastal belts. It has not been ploughed to the same extent as the Coastal Rhenosterbosveld. As in the case of the latter, there are indications that the climax is a grassy, more or less open scrub, at least on the south coast belt and on the Cape Flats. In the drier west coast belt, with its strictly winter rainfall, the climax is possibly a bush clump veld in grassy Fynbos. In either case it appears to have lacked the dense thorniness and semi-succulence of the scrub of heavier soils. Altitude ranges from 0–1,000 feet and rainfall from 11–20 inches per annum. On the west coast the rain falls in winter, but on the south coast a proportion, increasing eastwards, falls in summer.

No doubt the Fynbos species always occurred, the tall ones taking their place with the tropical species in the scrub, the smaller shrubs and other plants taking the part of forbs in the grassy parts. It is doubtful if the tropical grasses were ever dominant in the west coast belt; the only ones that have been seen are *Themeda triandra* and *Hyparrhenia hirta*.

The grasses which still occur in the southern coastal part of the coastal Macchia include:—

Themeda triandra.
Eragrostis capensis.
Aristida junciformis.
Brachiaria serrata.
Trachypogon capensis.
Digitaria littoralis.
D. eriantha.
Ehrharta spp.
Heteropogon contortus.
Cymbopogon plurinodis.

Festuca scabra.
Sporobolus capensis.
Tristachya hispida (eastwards).
Lasiochloa longifolia.
Eustachys paspaloides.
Eragrostis curvula.
Microchloa caffra.
Pentaschistis spp.
Danthonia stricta and other spp.
Hyparrhenia hirta.

Shrubs and trees (other than Proteaceae, etc., of the Fynbos) include:

Euclea racemosa.
E. undulata.
Sideroxylon inerme.
Cassine capensis.

Tarchonanthus camphoratus.
Rhus mucronata.
R. lucida.
R. crenata.

Gymnosporia buxifolia.
Pterocelastrus tricuspidatus.
Olea africana.
O. exasperata.
O. foveolata.
R. glauca.
Myrsine africana.
Cynanchum obtusifolium.
Asparagus racemosus.

Scrub forest, up to 30 feet high, composed of these species, is still to be found in the southern coast belt; but species are fewer in the west coast belt, and never, so far as has been seen, forming a scrub forest. The principal species are:—

Gymnosporia buxifolia.
Olea africana.
Rhus tomentosa.
R. glauca.
Euclea racemosa.
E. tomentosa.
Chrysanthemoides monilifera.
Zygophyllum morgsana.
Mundia spinosa.
Putterlickia pyracantha.
Royena glabra.
Pterocelastrus tricuspidatus.

with big bushy Restiads, especially *Willdenowia striata*, and tall Fynbos species of semi-karroid form, e.g. *Eriocephalus racemosus*. The big shrubs are mainly confined to small mounds which are more widely scattered in the sandy parts than they are in the clayey parts. It is a complex and interesting veld type and justice cannot be done to it in a page or two, particularly as the Fynbos element in it is a complete Fynbos, with all the typical families and genera. Furthermore, the Fynbos of the limestone in the Bredasdorp division will have to be regarded as a distinct veld type, as will the dwarf Fynbos of the Elim flats, when a detailed survey comes to be made.

All stages in the conversion of the climax scrub forest and scrub into grassless Fynbos can be found; while along parts of the National Road from Mossel Bay westwards its reconversion as far as the grassveld stage has already taken place.

VI.—PURE GRASSVELD TYPES.

These types occur on the upper plateau and the mountain tops at altitudes ranging from 3,500 to over 10,000 feet above the sea, in regions which are too dry and/or too frosty for the development of any kind of forest. Only on rocky hills, which are rare on the plains, and on the mountains, will a few scattered shrubs be found. Veld types 48–57 are tropical in affinity and are distinguished from one another mainly by the different proportions in which a handful of species occur. Veld types 58–60 are of mixed southern and tropical affinity, but the southern element has become dominant under prevailing conditions of veld management, i.e. to-day they are sharply distinct from the tropical types.

48. Cymbopogon–Themeda Veld.

This (together with No. 56), is the veld of the sandy parts of the wetter higher lying portion of the highveld in the north-eastern Cape, Orange Free State and south-central Transvaal, undulating to flat country. Altitude ranges from 4,500–6,500 feet above the sea, and rainfall from 18–30 inches per annum, falling in summer. Winters are severely frosty. Under these conditions, a mixed to sour grassveld is the climax; much of its has been ploughed up and the sandy soil is beginning to break down into sand.

Two variations can be recognized: (*a*) Southern variation in the Orange Free State and North-eastern Cape; (*b*) Northern variation in the Transvaal.

(*a*) *The Southern Variation of the Cymbopogon–Themeda Veld.*

This is a moderately dense grassveld, rather short; species of general occurrence are:—

Themeda triandra......	307,067	Tristachya hispida.....	47,992
Setaria flabellata.......	205,783	Helichrysum rugulosum	17,685
Microchloa caffra......	150,538	Brachiaria serrata......	9,545
Elyonurus argenteus....	126,650	Cymbopogon plurinodis	9,145
Heteropogon contortus	125,485	Harpechloa falx.......	6,968
Eragrostis chloromelas..	87,334	Hermannia depressa...	5,833
E. chalcantha..........	62,888	Eragrostis plana.......	3,014
E. capensis............	53,849		

Species of less general occurrence include:—

Digitaria tricholaenoides	23,202	Hermannia betonicaefolia	556
Kyllinga sp............	9,906	Aster muricatus........	537
Digitaria eriantha......	3,111	Aristida junciformis.....	491
D. monodactyla........	1,819	Helichrysum dregeanum.	369
Trichoneura grandiglumis	1,588	Vernonia kraussii.......	310
Senecio erubescens.....	724	Aristida diffusa var. burkei	165
Rhynchosia totta.......	678	Andropogon appendiculatus	84
Anthospermum rigidum	666		

and many more, the total number of species in the Relative Abundance Table being 150. *Eragrostis chloromelas* and *Microchloa caffra* tend to increase with overgrazing, and sometimes *Harpechloa falx*; but this veld type maintains its density well.

In better samples of this veld type, *Aristida junciformis* is not of importance. There are parts, however, especially around Reitz, where it is becoming dominant on shallow soil which tends to become waterlogged and on rather steep old lands which were abandoned many years ago because erosion had made the soil too shallow. *Scirpus burkei* is conspicuous in such places.

The Karoo invasion is well under way in this region, patches of *Pentzia globosa* and *Aster muricatus* developing on the heavier soil along valleys and on eroded shaly hillsides, in the latter habitat usually accompanied by *Aster filifolius.*

(*b*) *The Northern Variation of the Cymbopogon–Themeda Veld.*

This is a sparser, more tufted veld. Altitude ranges from 4,300–5,000 feet above the sea and rainfall from 20–27 inches per annum, falling in summer. Winters are frosty, as usual on the highveld.

Of general occurence are:

Setaria flabellata.......	121,300	Vernonia kraussii.......	1,500
Themeda triandra......	39,409	Eragrostis gummiflua....	1,500
Heteropogon contortus	26,816	Andropogon amplectens.	1,225
Eragrostis chalcantha...	20,096	Eragrostis capensis......	1,208
E. chloromelas.........	19,780	E. lehmanniana.........	950
Elyonurus argenteus....	15,600	Setaria nigrirostris......	696
Cymbopogon plurinodis	13,100	Scabiosa columbaria....	53
Brachiaria serrata......	12,480	Eragrostis plana........	8
Eragrostis obtusa.......	1,501	Ziziphus zeyheriana.....	6

Of less general occurence are:—

Digitaria argyrograpta	4,688	Conyza pinnata	832
Cynodon dactylon	2,926	Aster filifolius	832
C. incompletus	2,880	Panicum coloratum	800
Helichrysum rugulosum	1,000	Sporobolus discosporus	464
Anthospermum rigidum	832	Aristida congesta	371

This veld type merges easily into the western variation of the Bankenveld. It needs more study.

49. TRANSITIONAL CYMBOPOGON–THEMEDA VELD.

This veld type occupies drier country than the preceding type, receiving only 16 to 24 inches per annum, mostly 20 inches of rain per annum. It extends from the western edge of the *Cymbopogon–Themeda* veld to the small escarpment that runs down the middle of the Orange Free State, in an irregular belt, deeply indented from the west by the drier valleys of tributaries of the Vaal River, and from the east by wetter and sandier ridges. Were it not that most of the rock in this belt is dolerite, the vegetation would be *Cymbopogon–Themeda* veld, but the heavy doleritic soil causes it rather to resemble the Turf Highland in being strongly dominated by *Themeda*; but the presence of such species as *Aristida barbicollis, Panicum coloratum* and *Digitaria argyrograpta* and the absence of cultivation, show it to be, both actually and in effect, of a drier type; while the importance of *Eragrostis chloromelas* shows its relationship to the southern variations of the *Cymbopogon–Themeda* veld and *Dry Cymbopogon–Themeda* veld.

Species of general occurrence are:—

Themeda triandra	975,600	Kyllinga sp	1,700
Eragrostis chloromelas	246,960	Anthericum sp	1,670
Oxalis depressa	90,000	Aster muricatus	1,469
Microchloa caffra	31,667	Tragus racemosus	1,204
Aristida barbicollis	29,140	Crabbea acaulis	1,123
Sporobolus discosporus	14,400	Eragrostis lehmanniana	991
Panicum coloratum	11,559	Hermannia coccocarpa	870
Setaria flabellata	11,010	Walafrida densiflora	837
Digitaria argyrograpta	8,626	Chloris virgata	639
Cymbopogon plurinodis	6,356	Pentzia globosa	572
Gazania sp	5,667	Cynodon incompletus	408
Tragus koelerioides	5,200	Indigofera alternans	123
Osteospermum scariosum	4,837	Herniaria hirsuta	86
Elyonurus argenteus	4,302	Hibiscus atromarginatus	70
Setaria nigrirostis	3,837	Berkheya sp	68
Eragrostis obtusa	2,502	B. onopordifolia	57
Anthericum nataglencoense	2,500	Eragrostis plana	13
		E. superba	12
Helichrysum dregeanum	2,310	Scilla rigidifolia var. nervosa	2
Anthospermum rigidum	2,271		
Geigeria aspera	1,879	Talinum caffrum	0·5

There are few important species of less general occurrence, showing this to be a uniform veld type; they include:—

Heteropogon contortus	2,002	Cynodon dactylon	756
Lepturella capensis	2,000	Digitaria eriantha	578
Cyperus semitrifidus	1,111	Aristida bipartita	558

Overgrazing causes *Themeda* to be replaced by *Eragrostis chloromelas,* with little or no reduction in the cover. The total number of species in the Relative Abundance Table is 161.

Karoo invasion of this veld type is proceeding fast, taking two forms: (1) development of a mixed, grassy False Karoo in rocky places and along streams; (2) thickening up of already present plants of karroid form in eroded rocky places, particularly *Euryops densifolius.*

The small escarpment, which bounds this veld type on the west side has a fairly rich thornveld flora, in which the following species are important:—

Acacia karroo.
Grewia occidentalis.
Celtis kraussiana.
Olea africana.
Ziziphus mucronata.
Tarchonanthus camphoratus.
Rhus lancea.
R. undulata var. burchellii.
Ehretia rigida.
Buddleja salicifolia.
Royena pallens.
Euclea lanceolata.
Cussonia spicata.
C. paniculata.
Helinus integrifolius.
Cluytia pulchella.
Heteromorpha arborescens.

and others, while besides the grassveld grasses, the following occur: *Aristida canescens, A. bipartita, A. diffusa* var. *burkei, Hyparrhenia hirta, Enneapogon scoparius, Rhynchelytrum repens, R. setifolium, Setaria nigrirostris, Bothriochloa radicans* and *Panicum maximum.*

50. The Dry Cymbopogon–Themeda Veld.

This veld type lies to the west and south of the Transitional *Cymbopogon–Themeda* veld, at a lower elevation, and is drier. It has four variations: (*a*) Northern, north of the Vaal River on sandy soil. (*b*) Central, between the Vaal and Orange Rivers, as far south as Bloemfontein, mostly on sandy soil. (*c*) Southern, mostly on heavier soils, and distinguished by the presence of *Tetrachne dregei,* although this grass is now rare. (*d*) South-eastern, in the Upper White and Black Kei basin, mostly on sandy soils and lacking *Tetrachne.*

All four variations are dominated by *Themeda triandra* with *Cymbopogon plurinodis* the tallest grass, but usually not common; all are relatively sparse, especially the northern variation.

(*a*) *The Northern Variation of the Dry Cymbopogon-Themeda Veld.*

(See Hutchinson, p. 414.)

This lies at altitudes ranging from 4,200–4,500 feet above the sea, flat, sandy country receiving a summer rainfall of 17–23 inches per annum, and has frosty winters. Upwards it merges into the *Cymbopogon-Themeda* Veld, downwards into the bushveld and Kalahari Thornveld, with the appearance of stunted shrubs widely scattered in the open veld (mainly *Grewia flava* and *Royena pallens*), and bush on rocky outcrops.

Species of general occurrence are:—

Themeda triandra......	165,050	Triraphis andropogonoides	1,571
Setaria flabellata.......	142,282	Hypoxis rooperi........	93
Cymbopogon plurinodis	37,350	Lippia scaberrima.......	87
Eragrostis lehmanniana.	26,165	Eragrostis gummiflua....	84
Elyonurus argenteus....	10,727	Vernonia kraussii.......	70
Anthospermum rigidum.	7,625	Trichoneura grandiglumis	54
Heteropogon contortus.	6,606		

Eragrostis superba......	6,453	Barleria macrostegia....	9
Eustachys paspaloides..	5,417	Scilla rigidifolia var. nervosa	9
Eragrostis chloromelas.	5,347	Dicoma macrocephala...	7
Anthephora pubescens..	5,318	Sporobolus fimbriatus...	6
		Berkheya onopordifolia.	0·5

Species of less general occurrence include:—

Panicum coloratum....	19,577	Aristida graciliflora.....	273
Cynodon dactylon......	6,075	A. diffusa var. burkei...	113
Digitaria eriantha......	5,625	Brachiaria serrata.......	56
D. argyrograpta........	2,720	Aristida barbicollis......	50
Aristida uniplumis.....	1,801	Cymbopogon excavatus.	49
Aster muricatus........	473	Helichrysum callicomum	49

and many more, the number of species in the Relative Abundance Table being 140.

(*b*) *The Central Variation of the Dry Cymbopygon–Themeda Veld.* (See Adamson, Photo 13.)

This occupies very flat country at altitudes ranging from 4,200–4,500 feet above sea-level and receiving a summer rainfall of 17–20 inches per annum. Turfy parts are transitional both to the transitional *Cymbopogon-Themeda* Veld and the Pan Turf Veld; the sandier parts, which are more general, are transitional rather to the Kalahari Thornveld.

Species of general occurrence are:—

Themeda triandra......	310,874	Eragrostis chloromelas.	15,574
Aristida congesta.......	58,652	Heteropogon contortus.	11,929
Eragrostis lehmanniana.	53,188	Digitaria argyrograpta.	7,929
E. superba.............	45,163	Pogonarthria squarrosa	5,475
Cynodon dactylon......	41,237	Eragrostis atherstonei..	3,645
Setaria flabellata.......	41,077	Stachys spathulata.....	3,611
Tragus koelerioides.....	38,254	Euphorbia inaequilatera	1,859
Elyonurus argenteus....	29,003	Triraphis andropogonoides	1,716
Anthephora pubescens..	24,102	Anthospermum rigidum	653
Cymbopogon plurinodis	19,533	Dicoma macrocephala..	10

Species of less general occurrence include:—

Aristida barbicollis.....	12,680	Aristida uniplumis.....	492
A. graciliflora..........	3,828	Commelina africana....	417
Panicum coloratum.....	1,257	Aptosimum depressum.	392
Eragrostis obtusa.......	819	Aster muricatus........	298
Trichoneura grandiglumis	758		

and many more, the number of species in the Relative Abundance Table being 231.

As has been pointed out (p. 15), there are signs of thorn and Karoo invasion in both of these variations of the Dry *Cymbopogon-Themeda* Veld, though at present small and localized. The importance of *Aristida congesta*, *Eragrostis lehmanniana* and *Tragus koelerioides* shows the more arid nature of this veld.

(*c*) *The Southern Variation of the Dry Cymbopogon–Themeda Veld.*

This was formerly by far the most extensive of the variations of the Dry *Cymbopogon–Themeda* Veld, being the sweet grass veld that has so largely been invaded by Karoo to form the False Karoo. It was a particularly valuable sheep veld in having *Tetrachne dregei*, a broad-leaved *evergreen* grass forming stools up to three feet in diameter. The special value of this veld type has been destroyed, thrown away along with the soil and it is very doubtful if it can be fully restored.

Altitudes range from 4,000–5,000 feet above the sea, and rainfall from 17–20 inches per annum in the surviving parts of it, though relicts occur in areas receiving as little as 11 inches. The rainy season is in late summer.

Species of general occurrence are:

Themeda triandra......	301,254	Eragrostis obtusa.......	1,493
Tragus koelerioides.....	79,185	Sporobolus fimbriatus...	1,001
Eragrostis chloromelas..	56,509	Aster muricatus.........	179
Digitaria argyrograpta..	43,648	Walafrida saxatilis......	133
Cymbopogon plurinodis	39,931	Pentzia globosa.........	73
Eragrostis lehmanniana.	37,822	Chrysocoma tenuifolia..	70
Helichrysum dregeanum	17,954		

The poisonous *Moraea polystachya*, *Homeria pura* and *Gynandriris simulans* are generally abundant in depressions.

Species of less general occurrence include:—

Cyperus usitatus.......	19,570	Eragrostis curvula......	536
Ifloga paronychioides...	6,545	Indigofera alternans.....	506
Aristida congesta.......	6,188	Aristida diffusa var. burkei	431
Elyonurus argenteus....	3,223		
Osteospermum scariosum	1,992	Triraphis andropogonoides	345
Heteropogon contortus.	1,924		
Sporobolus discosporus.	1,013	Panicum stapfianum.....	332
Aristida curvata........	909	Eragrostis bicolor.......	300

and many more, the number of species in the Relative Abundance Table being 168.

(*d*) *The South-eastern Variation of the Dry Cymbopogon–Themeda Veld.*

Little information is available about this variation, but, in lacking *Tetrachne*, it is closer to the Central Variation than to the southern. Parts of it, at least, are distinguished by having *Eustachys paspaloides* among the abundant grasses. It has suffered considerably through drought in recent years, and is being invaded by *Acacia karroo*.

51. Pan Turf Veld.

This is the veld of the turfy soil on the flats around the pans of the western part of the Orange Free State. It is a very dense *Themeda* veld, but little is left in that condition. Under conditions of overgrazing, *Eragrostis obtusa*, as well as *E. chloromelas*, tend to repalce *Themeda*, and it is readily invaded by Karoo.

The principal species are:—

Themeda triandra.
Panicum coloratum.
Eragrostis chloromelas.
E. obtusa.
E. plana.
E. micrantha.
Setaria woodii var. fonssalutis.
Sporobolus fimbriatus.
Digitaria argyrograpta.

In the wetter, low-lying parts, *Echinochloa holubii*, *Sporobolus usitatus*, *S. tenellus*, *S.* sp. =A. 13532, *Platycarpha parvifolia*, *Diplachne fusca*, *Panicum laevifolium*, *Scirpus* spp. and *Eragrostis bicolor* are abundant.

52. Themeda Veld or Turf Highveld.

Occurring on black turf, this is an extremely dense *Themeda* veld, with no other species playing an important part. Most of it, where the soil is deep enough, is ploughed up. Elevation ranges from 5,000–5,700 feet above the sea, and rainfall from 25–30 inches per annum, falling in summer.

Species of general occurrence are:—

Themeda triandra	1,062,240	Cymbopogon plurinodis	6,521
Heteropogon contortus	79,552	Eragrostis chloromelas	4,317
Eragrostis chalcantha	51,236	E. plana	3,180
Tristachya hispida	49,009	E. capensis	2,811
Elyonurus argenteus	27,111	Anthospermum rigidum	1,995
Setaria nigrirostris	14,985	Digitaria diagonalis	1,072
Brachiaria serrata	7,378		

Species of less general occurrence include:—

Setaria flabellata	40,223	Helichrysum rugulosum	300
Trachypogon capensis	6,756	Vernonia kraussii	225
Aristida bipartita	2,137	Geigeria aspera	198
Microchloa caffra	1,956	Haplocarpha scaposa	12
Berkheya atractyloides	556	Cymbopogon excavatus	5

and others, the number of species in the Relative Abundance Table being 78.

This veld extends along watercourses far into the surrounding veld types. The poisonous *Geigeria aspera* is a potential danger.

53. Patchy Highveld to Cymbopogon–Themeda Veld Transition.

This is not, strictly speaking, a veld type at all, but merely a maze of patches of Turf Highveld on turfy soil, of *Cymbopogon–Themeda* veld on sandy soil, with outliers of Bankenveld on rocky outcrops along its northern margin. It is not such flat country as most of the highveld, undulating across the valleys of the Wilge River and various spruits draining into the Orange River.

54. Turf Highveld to Highland Sourveld Transition.

This veld type, lying mostly between 5,500 and 6,000 feet above the sea, and receiving a rainfall of about 30 inches per annum, links veld type 52 with the Highland Sourveld and North-Eastern Sandy Highveld. It is not so completely dominated by *Themeda* as is the Turf Highveld, is more mixed, denser and sourer.

Species of general occurrence are:—

Themeda triandra	727,200	Helichrysum rugulosum	5,519
Heteropogon contortus	331,900	Eragrostis chloromelas	5,370
Tristachya hispida	284,400	Digitaria monodactyla	5,196
Harpechloa falx	69,486	Andropogon appendiculatus	4,862
Digitaria tricholaenoides	49,278	Brachiaria serrata	4,725
Setaria flabellata	44,894	Eragrostis plana	2,517
Elyonurus argenteus	39,750	Andropogon amplectens	1,875
Eragrostis chalcantha	27,938	Cymbopogon plurinodis	1,252
Microchloa caffra	10,075	Andropogon schirensis	655
Eragrostis capensis	5,625	Aristida junciformis	501

i.e. a good transitional type. The only species of importance that is not of general occurrence is *Trachypogon capensis* 19,577, showing this to be a uniform veld type.. Scrub forests of *Leucosidea sericea* occur on mountain sides at its upper margin.

The total number of species in the Relative Abundance Table is 80, but no mountain sides were included in the samples.

55. Bankenveld to Turf–Highveld Transition.

Besides the area mapped as this veld type, there are smaller patches along the northern edge of the Turf Highveld. It is a *Themeda* dominated veld, but includes some of the sourer grasses in important quantities, e.g. *Trachypogon capensis*, *Monocymbium ceresiiforme*, *Andropogon* spp., *Aristida junciformis* and *Tristachya hispida.* Little information is available about it.

56. Highland Sourveld to Cymbopogon–Themeda Veld Transition.

(See Taljaard, Photos 64, 65, 67.)

This veld type links the *Cymbopogon–Themeda* veld with the Highland Sourveld in the highest and wettest part of the Orange Free State, at altitudes ranging from 5,000–6,500 feet above the sea and under a rainfall of 25–35 inches per annum. Soils are sandy. An important outlier of it, at 4,000–5,500 feet above the sea, occurs on the Cedarville Flats and in other fairly flat, sandy country around Mount Fletcher, Matatiele and Kokstad, with a smaller outlier near Volksrust and others too small to map. It is a good transitional type, having *Cymbopogon* and *Eragrostis capensis* of the *Cymbopogon–Themeda* veld with many of the sour grasses of the Highland Sourveld, and *Themeda* is only co-dominant with *Tristachya hispida.* This importance of *Tristachya* suggests an affinity with the North-Eastern Sandy Highveld and other more northern veld types.

Species of general occurrence are:—

Themeda triandra......	367,760	Helichrysum rugulosum.	1,464
Tristachya hispida......	367,760	Cyperus compactus var..	1,024
Elyonurus argenteus....	143,560	Vernonia kraussii.......	1,022
Eragrostis chalcantha...	133,080	Ajuga ophrydis.........	840
Digitaria tricholaenoides	117,840	Haplocarpha scaposa....	572
Heteropogon contortus.	72,685	Hermannia depressa.....	562
Harpechloa falx........	63,708	Anthospermum rigidum.	560
Digitaria monodactyla..	15,539	Ipomoea crassipes......	504
Microchloa caffra......	13,552	Lasiosiphon kraussianus	211
Trachypogon capensis..	8,928	Rhynchosia totta.......	64
Brachiaria serrata......	8,854	Walafrida densiflora....	56
Eragrostis capensis.....	8,643	Indigofera rostrata......	51
E. chloromelas.........	6,497	Senecio coronatus.......	45
Oldenlandia amatymbica	4,863	S. erubescens...........	45
Andropogon schirensis..	3,400	Sonchus nanus.........	45
Hypoxis rigidula.......	3,318	Asclepias multicaulis....	22
Cymbopogon plurinodis	2,489	Euphorbia striata.......	9
Helichrysum latifolium.	1,676		

Species of less general occurrence include:—

Setaria flabellata........	3,680	Lotononis calycina......	300
Aristida congesta........	1,442	Hieracium capense......	35
Andropogon appendiculatus	1,254	Hermannia (Mahernia betonicaefolia)	34

Aristida junciformis	440	Eragrostis plana	31
Fimbristylis monostachya	419	Pentanisia prunelloides	20
Gazania spp	313	Ipomoea greenstockii	4
Helichrysum nudifolium	313	Scabiosa columbaria	4
Aristida diffusa var. burkei	302	Boöphone disticha	0·2

and many more, the number of species in the Relative Abundance Table being 160.

This region, especially in the Orange Free State, is not so flat as that occupied by the *Cymbopogon–Themeda* veld, being more rolling and broken. The rock is mainly sandstone. On the rocky slopes patches of bush, sometimes almost scrub forest, occur; the principal species include:—

Celtis kraussiana.
Olea africana.
Kiggelaria africana.
Myrsine africana.
Rhus erosa.
R. dentata var. grandifolia.
R. macowanii.
R. divaricata.
Buddleja salvifolia.
Rhamnus prinoides.
Euclea lanceolata.
Royena hirsuta.
Gymnosporia buxifolia.
Cluytia pulchella.
Rhoicissus cuneifolius.
Grewia occidentalis.
Halleria lucida.
Rubus ludwigii and others.

with *Leucosidea sericea* becoming important at higher levels.

Similar bush occurs down the eastern side of the *Cymbopogon–Themeda* Veld.

57. NORTH-EASTERN SANDY HIGHVELD.

This corresponds to the *Cymbopogon–Themeda* veld to Highland Sourveld transition and the Highland Sourveld southwards, but has a strong Bankenveld affinity. Altitude ranges from 5,300–7,000 feet above the sea and rainfall ranges from 30–37 inches per annum, falling in summer. It has two variations: (*a*) Near–Bankenveld, occurring mainly on the western side of the low watershed which here represents the Drakensberg. (*b*) Near Highland Sourveld, mainly on the top and eastern side of the watershed.

(*a*) *Near–Bankenveld Variation of the North-eastern Sandy Highveld.* The species of general occurrence are:—

Tristachya hispida	518,850	Elyonurus argenteus	10,063
Trachypogon capensis	272,056	Alloteropsis semialata var. ecklonii.	9,288
Themeda triandra	256,978	Panicum natalense	9,284
Heteropogon contortus	193,733	Helichrysum oreophilum	5,639
Eragrostis chalcantha	155,227	Brachiaria serrata	4,314
Digitaria tricholaenoides	113,883	Ctenium concinnum	4,080
Monocymbium ceresiiforme	47,690	Eragrostis plana	3,105
Microchloa caffra	40,547	Andropogon amplectens	2,041
Loudetia simplex	32,361	Harpechloa falx	1,607
Andropogon schirensis	23,898	Eragrostis sclerantha	1,135

Of less general occurrence are:—

Rendlia nelsonii	21,602	Sporobolus pectinatus	1,152
Tristachya rehmannii	2,425	Dicoma anomala	834
Andropogon filifolius	1,629	Schizachyrium semiberbe	602
Aristida aequiglumis	1,472	Panicum ecklonii	407
A. junciformis	1,238	Eragrostis patentissima	310

and many more, the total number of species in the Relative Abundance Table being 103.

So *Themeda* is not dominant in this veld type, its place being taken by sourer species; the veld, however, is dense. In winter it acquires the grey, dead look of Bankenveld, lacking the purplish colour of *Themeda* as dominant.

(*b*) *Near-Highland Sourveld Variation of the North-eastern Sandy Highveld.*

In this case, *Themeda* is the dominant, although the list of species is much the same as in the other variation, and the veld is just as dense.

The species of general occurrence are:—

Themeda triandra	500,251
Tristachya hispida	456,693
Digitaria tricholaenoides	211,911
Heteropogon contortus	180,400
Eragrostis chalcantha	148,880
Trachypogon capensis	83,264
Microchloa caffra	75,129
Andropogon appendiculatus	26,127
Rendlia nelsonii	21,250
Monocymbium ceresiiforme	14,479
Andropogon schirensis	10,057
Elyonurus argenteus	8,928
Brachiaria serrata	6,625
Alloteropsis semialata var. ecklonii.	6,229
Aristida junciformis	4,247
Harpechloa falx	3,854
Helichrysum rugulosum	1,682

Of less general occurrence are:—

Loudetia simplex	10,371
Andropogon filifolius	5,568
Eragrostis chloromelas	3,486
Bulbostylis sp	3,250
Setaria nigrirostris	2,233
Eragrostis capensis	2,169
E. plana	1,333
Andropogon amplectens	890
Hypoxis rigidula	803
Euryops setilobus	711
Anthospermum rigidum	668
Berkheya setifera	465
Ctenium concinnum	45

and many more, the number of species in the Relative Abundance Table being 118.

58. Themeda–Festuca Alpine Veld.

This is the veld of the Drakensberg above 6,000–7,000 feet, receiving a rainfall ranging from 23 to over 75 inches per annum on the highest points, so that a good deal of variation is to be expected. There is, nevertheless, a remarkable degree of uniformity all along the mountains from about Naudes Nek Pass along the Drakensberg, Stormberg, Bamboesberg, Suurberg, Kikvorschberg and Sneeuwberg to the eastern part of the Nieuwveld Range, suggesting that other factors than total rainfall are important in controlling the nature of the vegetation on these mountains.

It is a short, dense grassveld, varying from sweet to mixed, dominated by *Themeda triandra* with an admixture of the usual grassveld species, e.g.:

Elyonurus argenteus.
Heteropogon contortus.
Eragrostis chloromelas.
E. chalcantha.
E. capensis.
E. curvula.
Microchloa caffra.
Andropogon filifolius.
A. appendiculatus.
Trachypogon capensis.
Cymbopogon marginatus.
Harpechloa falx.
Aristida diffusa var. burkei.

but it has, also, a high proportion of grasses of less usual occurrence (many being of southern affinity), especially at higher altitudes, e.g.:—

Festuca costata.
F. scabra.
F. caprina and others.
Danthonia disticha.
D. purpurea.
D. macowanii and others.
Helictotrichon hirtulum.
Tetrachne dregei.
Eragrostis caesia.
Setaria sphacelata.
Pentaschistis microphylla.
P. natalensis and others.
Brachiaria serrata var.
Koeleria cristata.
Poa binata.
Bromus firmior and others.

There was, and sometimes still is, scrub forest in sheltered kloofs, in which *Leucosidea sericea* is the dominant, along with:—

Buddleja salvifolia.
Polemannia grossulariaefolia.
Rhamnus prinoides.
Myrsine africana.
Erica caffra.
Cluytia pulchella.
and others.
Olea africana.
Rhus lucida.
Celtis kraussiana.
Buddleja corrugata.
Arundinaria tesselata.

The soil is generally of a black, turfy nature, derived from the Drakensberg basalt, even on the cave sandstone below, and is very erodible. *Danthonia disticha* becomes dominant, especially on shallow soil and on rocky outcrops; but the main effect of mismanagement is to convert this veld into a Karroid False Fynbos; i.e., in either case mismanagement encourages the southern element of the flora. A form of Fynbos is a natural part of this vegetation, especially on the eastern side of the Drakensberg, but, although species of this Fynbos may spread, the present development is mainly on the western side of the mountains and is an invasion of the karroid form of near-Fynbos that we find all along the tops of the Karoo mountain ranges. The natural Fynbos relicts consist of *Passerina montana*, *Erica woodii*, *E. drakensbergensis*, *E. ebracteata*, *E. thodei*, *Phylica paniculata*, *Cliffortia nitidula* and others, often with *Encephalartos ghellinckii* and *Widdringtonia dracomontana* and with a high proportion of species belonging to the forest margin; but in the Karroid False Fynbos, few of these typically Fynbos species occur, excep *Passerina montana* and *Erica caffra*. Besides these two, important species in the Karroid False Fynbos are:—

Chrysocoma tenuifolia.
Aster filifolius.
Euryops tenuissimus.
E. racemosus.
E. candollei.
E. floribundus.
Pentzia cooperi.
Walafrida saxatilis.
Helichrysum splendidum.
Sutera pristisepala.
Rhus erosa.
Royena hirsuta.
Nestlera acerosa.
Eriocephalus punctulatus.
Aster petiolatus.
Cliffortia ramosissima.
Cluytia pulchella.
Selago speciosa.
Artemisia afra w.
Indigofera spinescens.
Stoebe vulgaris.
Metalasia muricata.
Relhania pungens.

and others.

A curious sight in this veld is *Euphorbia mauritanica* growing under *Leucosidea sericea.* The presence of *Aloe ferox* on northern aspects in the Telle Drift area illustrates how elements of the eastern coastal flora could have migrated along the mountains of the north-east Cape into the Orange River valley at a time when conditions were warmer than they are now.

59. STORMBERG PLATEAU SWEETVELD.

This veld type is transitional from the preceding to the Karroid Danthonia Mountain Veld; it differs mainly in occupying a plateau instead of steep-sided mountains, on rocks (of the Molteno series) which readily weather into a deep soil. At altitudes ranging from 5,000–6,500 feet, and under a rainfall of 20–25 inches, we find a sweet grassveld developed, which much resembles the vlei vegetation of these other two veld types. In general it is a *Themeda*-dominated veld on a black, peaty soil; it tends to become sourer when selectively grazed, with an increase in *Elyonurus argenteus.* It includes a high proportion of:—

Pennisetum sphacelatum.
Tetrachne dregei.
Festuca scabra.
Eragrostis chloromelas.
E. curvula.
E. capensis.
Danthonia purpurea.
Koeleria cristata.
Pentaschistis microphylla.
Helictotrichon hirtulum.
Ehrharta sp.
Digitaria sp.
Harpechloa falx.

with *Danthonia disticha*, *Aristida diffusa* var. *burkei* and *Cymbopogon plurinodis* dominant on rocky sandstone outcrops, but *Themeda* completely dominant on dolerite outcrops. A feature of this plateau is the extensive vleis, which are dominated by *Tetrachne*, with *Festuca scabra*, *Fingerhuthia sesleriaeformis*, *Eragrostis chloromelas* and some *Themeda*, an extremely dense, deep veld. In tramped out veld, *Danthonia purpurea*, *Pentaschistis microphylla* and other small grasses become important.

The hills are being invaded by Karroid False Fynbos, in which *Aster filifolius* is sometimes conspicuous.

Small outliers of this veld type appear to occur on the Suurberg plateau, but are very badly tramped out and invaded by Karoo.

60. KARROID DANTHONIA MOUNTAIN VELD.

Starting in the east as patches on rocky, dry aspects in the *Festuca–Themeda* Alpine Veld and Stormberg Plateau Sweetveld, this veld type covers all the higher mountains of the False Karoo and Central Upper Karoo, as far west as the Beaufort West division, where *Danthonia disticha* is replaced by *Danthonia stricta* and the veld of the remainder of the mountain tops, to the Hantamsberg and Kamiesberg, is what has been separated as Mountain Rhenosterbosveld. Mountain Rhenosterbosveld, however, is closely related to the Karroid *Danthonia* Mountain Veld. The latter also covers the inland slopes of the Winterberg and Katberg to the neighbourhood of Cathcart.

The dominant grass all through is *Danthonia disticha*, and although it may be the natural dominant in rocky sandstone parts, it is probable that in all dolerite parts and all parts covered with soil, *Themeda* and *Tetrachne* are the natural dominants, together with such species as:—

Ehrharta calycina.
Eragrostis chloromelas.
P. sp. (= A. 11960)
Danthonia curva.

Melica decumbens.
Festuca scabra.
Danthonia purpurea.
D. stricta.
Helictotrichon hirtulum.
H. turgidulum.
Pentaschistis sp. = A. 15700.
Eustachys paspaloides.
Fingerhuthia sesleriaeformis W.
Koeleria cristata.
Brachypodium sp. = A. 16165.
Bromus leptoclados.
Cymbopogon prolixus.
Bromus catharticus.

with a variety of non-grasses, e.g.:—

Diascia capsularis.
Sutera macrosiphon.
Dianthus caespitosus.
Othonna auriculaefolia.
Urtica dioica w.
Ficinia sp. (= A. 15994).
F. sp. (= A. 16157).
Pelargonium aridum.
P. dichondraefolium.
Schoenoxiphium sp. (= A. 15990).
Pelargonium ramosissimum.
Notholaena eckloniana.
Cheilanthes hirta.
Stachys aethiopica.
Chenopodium virgatum.
Senecio othonniformis.
Delosperma sp. (= A. 16279).
Euphorbia epicyparissias.
Melolobium sp. (=A. 15989).

and many more.

In the wetter parts, e.g. Zwagershoek Pass and the Winterberg, grasses like *Elyonurus argenteus*, *Festuca costata*, *Heteropogon contortus*, *Bromus firmior*, *Pennisetum sphacelatum*, *Eragrostis chalcantha* and *Pentaschistis* sp. suggest a transition to *Festuca-Themeda* Mountain Veld and Dohne Sourveld. Southern aspects in this veld have traces of scrub forest and Fynbos, but the transition to the *Aristida diffusa*—dominated open mountain scrub of the Karroid Broken Veld is so easy that there is no clear dividing line. The scrub species are the same as in the Karroid Broken Veld scrub, but the Fynbos is sometimes surprisingly complete, though it lacks such important groups as *Proteaceae* and *Rutaceae*, e.g. on the Bamboesberg. Species of definitely Fynbos affinity occurring here and growing densely are:—

Elytropappus rhinocerotis.
Erica caffra.
Cliffortia ramosissima.
C. sp. = A. 15906.
C. tuberculata.
Tetraria sp.cf. T. macowanii.
Ficinia sp. = A. 15900.
Metalasia muricata.
Ursinia apiculata.
Restio sp.
Philippia sp.
Muraltia macroceras.
Passerina montana.
Eumorphia dregeana.
E. corymbosa.
Pentzia cooperi.
Pelargonium quercifolium.
P. multicaule.
Anthospermum sp. = A. 15844.
Cluytia polifolia.

but, as a rule, these (with the exception of *Elytropappus* sometimes dominant, *Eumorphia dregeana* and *Anthospermum*) are scarce, the more karroid species being dominant, e.g.:—

Chrysocoma tenuifolia.
Euryops oligoglossus.
Helichrysum hamulosum.
Eriocephalus punctulatus.
E. eximius.
Dimorphotheca cuneata.
Nestlera prostrata.
Aster filifolius.
Helichrysum trilineatum (eastwards).
H. niveum.
Walafrida saxatilis.
Melolobium spp.

Where areas of bare rock, especially dolerite, are exposed in this veld. even on the mountain tops, a sparser, semi-succulent vegetation is found, The principal succulents are at least four species of bushy *Ruschia* (not yet found in flower), with *Sarcocaulon patersonii*, *Adromischus nanus*, *A. maculatus*, *Aloe striatula*, *A. broomii*, *Delosperma* sp., *Anacampseros ustulata*, *A. telephiastrum*, *Ruschia indurata*, *Stomatium peersii*, *Chasmatophyllum musculinum*, *Cotyledon* sp., *Euphorbia rectirama*, *E. aggregata*, *Crassula corallina* and other small *Crassula* spp.

VI.—FALSE GRASSVELD TYPES.

61. BANKENVELD.

(See Taljaard, Photo 71; King, Figs. 229, 230, 234.)

It is possible that the climax of this veld type was an open savannah of *Acacia caffra*; certainly it still is in parts along its northern margin and sour bushveld regularly occurs on rocky outcrops and hills. It is a sparse and tall tufted type with the forbs playing an important part, and is extremely sour.

Three variations can be recognized: (*a*) The Western Variation, on sandy plains. (*b*) The Central Variation, of the Witwatersrand area, high-lying, largely stony country, with rolling topography. (*c*) The Eastern Variation, on sandy plains, but wetter than (*a*).

(*a*) *The Western Variation of Bankenveld.*

This occurs on sandy plains and low rocky ridges, ranging in altitude from 4,500–5,500 feet above the sea and receiving about 22–27 inches of rain per annum, falling in summer. It is a rather sparse, sour, strongly tufted veld and, in the nature of its grasses, clearly transitional from the *Cymbopogon–Themeda* veld to the Sour Bushveld. The presence of important quantities of *Cymbopogon plurinodis*, and the general absence of *Tristachya hispida* distinguish it from the Central and Eastern Variations.

Species of general occurrence are:—

Eragrostis chalcantha..	138,800
Digitaria tricholaenoides	119,683
Setaria flabellata......	108,640
Heteropogon contortus	76,444
Eragrostis chloromelas	36,000
Elyonurus argenteus...	35,337
Themeda triandra.....	30,089
Trachypogon capensis.	14,767
Brachiaria serrata.....	14,760
Andropogon amplectens	13,764
Cymbopogon plurinodis	13,200
Tristachya rehmannii..	5,376
Justicia anagalloides...	5,340
Bulbostylis burchellii..	4,880
Schizachyrium semiberbe	3,747
Cassia mimosoides....	2,859
Senecio venosus.......	2,537
Acalypha angustata...	2,448
Bewsia biflora..........	2,426
Triraphis andropogonoides	2,338
Helichrysum caespiticium	1,644
Trichoneura grandiglumis	1,264
Aristida diffusa var. burkei	873
Cymbopogon excavatus.	818
Crabbea angustifolia....	676
Vernonia kraussii.......	676
Pogonarthria squarrosa.	613
Senecio coronatus.......	609
Elephantorrhiza elephantina	571
Andropogon schirensis..	522
Loudetia simplex.......	102
Ziziphus zeyheriana.....	91
Hypoxis rooperi........	45

Species of less general occurrence include:—

Pygmaeothamnus zeyheri	14,216
Tristachya hispida (eastwards)	7,400
Digitaria eriantha var. stolonifera	1,937
Anthospermum rigidum	1,216
Oldenlandia amatymbica	1,201
Digitaria monodactyla..	1,172
Eustachys paspaloides..	1,032
Cyperus margaritaceus.	856
Becium obovatum......	832
Indigofera oxytropis....	817
Oxygonum zeyheri.....	800
Dicoma anomala.......	448
Walafrida densiflora.....	443
Ophrestia retusa........	433
Sphenostylis angustifolia	324
Aristida aequiglumis....	197
Cyanotis nodiflora......	64
Stoebe vulgaris.........	42
Arthrosolen sericocephalus	30
Zornia tetraphylla......	22
Clematopsis stanleyi.....	1

and many more.

The number of species in the Relative Abundance Table is 203.

Bauhinia esculenta, with edible seeds, is of rare occurrence in this veld, but is common in parts of the marginal Kalahari Thornveld in Vryburg and Kuruman divisions.

(*b*) *The Central Variation of the Bankenveld.*

This is the veld of the Witwatersrand and the high undulating country sloping down to the Magaliesberg, of the hills southwards towards the Vaal River, and of the northern edge of the eastern part of the Bankenveld. The rocks are mainly quartzite, shale, dolomite and chert and granite, and the soils poor and acid, either stony or sandy. Altitude ranges from 4,700–5,700 feet above sea-level and rainfall from 27–30 inches per annum, falling in summer. The winters are severely frosty. Under these conditions, combined with regular burning, the veld is a particularly sour, wiry grassveld, virtually ungrazable in winter. On the other hand, the experiments at Rietvlei Research Station have shown what possibilities this veld offers for semi-intensive farming. Rocky hills and ridges carry a Bushveld vegetation dominated by *Protea caffra*, *Acacia caffra*, *Celtis kraussiana* and sometimes *Protea hirta*, with a large number of the Sour Bushveld shrubs in smaller quantity. A typical plant of the hills is *Vellozia retinervis*. In sheltered valleys and sink-holes there are traces of temperate or transitional forest, with such species as *Celtis kraussiana*, *Kiggelaria africana*, *Halleria lucida*, *Leucosidea sericea*, *Buddleja salvifolia* and *Cassinopsis ilicifolius*, e.g. in Fountains Valley at Pretoria, contrasting strongly with the traces of tropical forest a few miles away in the kloofs of the northern slopes of the Magaliesberg.

The typical species of the grassveld include:—

Trachypogon capensis.
Tristachya hispida.
Elyonurus argenteus.
Heteropogon contortus.
Panicum natalense.
Andropogon amplectens.
Schizachyrium semiberbe.
Loudetia simplex.
Brachiaria serrata.
D. tricholaenoides.
Setaria flabellata.
S. nigrirostris.
Eragrostis chalcantha.
E. chloromelas.
E. capensis.
E. sclerantha.
E. gummiflua.
Themeda triandra.

Tristachya rehmannii.
Bewsia biflora.
Monocymbium ceresiiforme.
Digitaria monodactyla.
Urelytrum squarrosum.
Aristida aequiglumis.
Rhynchelytrum setifolium.
Cymbopogon excavatus.

with a great wealth of forbs, e.g.:—

Sphenostylis angustifolia.
Senecio coronatus.
S. fraudulentus and others.
Helichrysum acutatum.
H. agrostophilum and others.
Nidorella hottentotica and others.
Indigofera hilaris.
I. fastigiata.
I. velutina and others.
Geigeria burkei.
Justicia anagalloides.
Cycnium adonense.
Pleiospora cajanifolia.
Vernonia natalensis and others.
Pentanisia prunelloides.
Castalis spectabilis.
Parinari capense.
Pygmaeothamnus zeyheri.

and many more.

Much of this country has been ploughed up in the past by natives (Moselekatze's people were settled here). On these ancient lands, *Hyparrhenia hirta* is abundant and a feature of the flatter parts of this veld type. In the sandier parts, overgrazing will bring in abundance of *Stoebe vulgaris*; on rocky ridges, of *Helichrysum kraussii.* It would appear that the southern element in this flora is strong, even though it is small in numbers.

(*c*) *The Eastern Variation of the Bankenveld.*

This is very flat sandy country. On the rocky outcrops, the veld resembles the Central Variation, as it does along the northern margin, being transitional to Sour Bushveld. Rainfall ranges from 24–30 inches per annum and altitude ranges from 4,500–5,500 feet.

Species of general occurrence are:—

Tristachya hispida......	132,154
Eragrostis chalcantha...	107,640
Heteropogon contortus.	82,425
Trachypogon capensis..	59,418
Digitaria tricholaenoides	51,390
Themeda triandra......	48,859
Brachiaria serrata......	48,382
Microchloa caffra......	33,006
Elyonurus argenteus....	29,811
Andropogon amplectens	23,064
Schizachyrium semiberbe	14,642
Panicum natalense......	10,705
Monocymbium ceresiiforme	10,381
Eragrostis chloromelas.	4,844
Bewsia biflora..........	4,267
Tristachya rehmannii....	3,344
Andropogon schirensis..	2,646
Helichrysum coriaceum..	2,046
Eragrostis plana........	1,884
Aristida aequiglumis....	1,659
Urelytrum squarrosum..	1,381
Aristida congesta.......	1,288
Cymbopogon excavatus.	873
Eragrostis gummiflua...	537
Hyparrhenia hirta.......	398
Stoebe vulgaris.........	88
Dicoma anomala.......	23

Species of less general occurrence include:—

Digitaria monodactyla..	40,875
Loudetia simplex.......	13,426
Setaria flabellata.......	10,149
Ficinia spp............	4,178
Cynodon dactylon......	2,895
Sporobolus centrifugus.	2,432
Setaria nigrirostris......	1,095
Schizachyrium ursulus...	1,005
Acalypha angustata.....	963
Eragrostis sclerantha....	867
Aristida junciformis.....	622
Harpechloa falx........	395

Andropogon filifolius...	2,281	Vernonia kraussii.......	342
Eragrostis capensis.....	1,635	Alloteropsis semialata var. ecklonii.	171
Ctenium concinnum....	1,571	Eragrostis curvula......	89
Parinari capense........	1,478	Senecio coronatus.......	4

and many more, the number of species in the Relative Abundance Table being 201. *Tristachya biseriata* is sometimes abundant on rocky outcrops. Eastwards, this veld type merges gradually into the North-Eastern Sandy Highveld.

In loosely sandy parts of this veld, the grass is particularly wiry and sparse, dominated by such species as *Digitaria brazzae*, *Tristachya rehmannii*, *Eragrostis curvula*, *E. chalcantha* and *Perotis indica*, with some *Themeda* and *Heteropogon*. Outliers on sandstone in the North-Eastern Sandy Highveld, likewise are extraordinarily sour and wiry, including the more useful grasses only as rareties. The north-eastern outliers, at Lydenburg and in sandy valleys in the mountains between Lydenburg and Roos Senekal, are a little different, being transitional to Piet Retief Sourveld in having *Eulalia villosa*, rather more *Themeda*, and both *Elyonurus* and *Loudetia* of a form which is typical of the Piet Retief Sourveld. A conspicuous forb in this veld around Lydenburg is *Argyrolobium wilmsii.*

62. Bankenveld to Sour Sandveld Transition.

This is very sour veld on pale, sandy soil, closely related to the sandier parts of the Eastern Variation of the Bankenveld, but lacking such species as *Tristachya rehmannii* and *Schizachyrium semiberbe.* It requires more study.

63. Piet Retief Sourveld.

In this veld type, as in the Bankenveld, there are indications that it could originally have been thornveld or bushveld of an open, sour type, with scrub forest in sheltered places. That is the reason for including it among the false grassveld types, although it is, to-day, for practical purposes grassveld, with patches of bush and scrub-forest in sheltered places. Its altitude ranges from 3,000–5,500, mostly 4,000–5,000 feet, and its rainfall from 30–45 inches per annum, falling in summer.

The scrub-forest relicts include:—

Scolopia mundtii.
Leucosidea sericea.
Pittosporum viridiflorum.
Cephalanthus natalensis.
Buddleja auriculata.
Faurea speciosa.
Myrsine africana.
Apodytes dimidiata.
Olinia sp.
Rhus pyroides.
R. transvaalensis.
R. dura.
Pterocelastrus tricuspidatus.
P. echinatus.
Royena cordata.
R. sp. cf. R. pallens.
Tapiphyllum parvifolium.
Cyathea dregei.
Cussonia spicata.
Halleria lucida.
Ficus capensis.
F. petersii.
F. sonderi.
Syzygium cordatum W.
Dalbergia obovata.
Maesa lanceolata.
Acacia davyi.
A. woodii.
Heteromorpha trifoliata.
Rhamnus prinoides.
Sparmannia ricinocarpa.
Trimeria trinervis.
Lasiosiphon anthylloides.
Protea rouppelliae.

Osyris compressa.
Dais cotinifolia.
Greyia sutherlandii.
Ekebergia pterophylla.
Lopholaena platyphylla.

and many more, a rich and varied flora, very different from the simple *Leucosidea* scrub which occurs as a post climax above the real upper limit of the forest, e.g. near Wakkerstroom, near Clarens and west of Majuba.

On the escarpment at the upper edge of this veld type are some surprisingly complete Fynbos relicts, e.g. on Athole Research Station, east of Ermelo. Here, on sandstone ledges and small krantzes above the relicts of scrub forest, mainly *Cyathea dregei*, occur small patches of Fynbos-like vegetation, with such species as the following:—

Protea rouppelliae.
Erica oatesii.
E. cerinthoides.
E. alopecurus.
Osmunda regalis.
Psoralea polysticta.
Poa binata.
Metalasia muricata.
Restio sieberi var. schoenoides.
Athanasia punctata

and patches of *Festuca costata* on the slopes.

The grassveld is sour and rather sparse; large tufts of *Eulalia villosa*, with their dark, red-brown colour in winter, are typical of this veld.

Species of general occurrence are:—

Tristachya hispida......	220,200
Themeda triandra......	119,640
Rendlia nelsonii........	70,952
Eragrostis chalcantha...	55,235
Andropogon schirensis.	45,344
Monocymbium ceresiiforme	35,367
Trachypogon capensis..	31,762
Microchloa caffra......	26,736
Brachiaria serrata......	22,093
Andropogon amplectens	19,002
Heteropogon contortus.	10,418
Alloteropsis semialata var. ecklonii	9,973
Loudetia simplex......	5,940
Hyparrhenia hirta......	5,472
Digitaria tricholaenoides	4,102
Setaria nigrirostris.....	2,945
Eulalia villosa.........	2,708
Eragrostis plana.......	2,645
Panicum natalense.....	1,252
Berkheya setifera......	571

Species of less general occurrence include:—

Andropogon filifolius...	11,937
Aristida junciformis....	9,776
Elyonurus argenteus....	6,810
Cymbopogon excavatus	1,947
Ctenium concinnum....	971
Panicum ecklonii.......	890
Helichrysum oreophilum	847
Pentanisia prunelloides.	685
Vernonia natalensis....	676
Harpechloa falx.......	233
Helichrysum simillimum	215
Schizachyrium semiberbe	21
Dicoma anomala......	5

and many more, the number of species in the Relative Abundance Table being 134.

Forbs are particularly common and showy in this veld type, but as this survey was made mostly in winter, few of them figure in the Relative Abundance Table. The spectacular soil erosion in this region has already been mentioned (p. 47); the vertical sides of these big dongas will sometimes be found to be completely stabilized by a stoloniferous fern, *Gleichenia linearis*, an interesting demonstration of the capabilities of the pre-angiosperm flora.

64. THE NORTHERN TALL GRASSVELD.

Even more than the Piet Retief Sourveld, this veld type is a patchwork of *Hyparrhenia*-dominated old lands; but otherwise it is a sourveld, completely dominated by *Tristachya hispida*. The granite on which most of it occurs will no doubt explain this.

Species of general occurrence are:—

Tristachya hispida......	330,767	Setaria nigrirostris.....	14,044
Eragrostis chalcantha...	90,964	Brachiaria serrata......	12,683
Microchloa caffra......	45,978	Cymbopogon excavatus	4,328
Andropogon amplectens	35,240	Andropogon schirensis.	2,908
Rendlia nelsonii........	33,223	Loudetia simplex......	2,572
Trachypogon capensis..	32,969	Alloteropsis semialata var. ecklonii.	2,269
Themeda triandra......	27,426	Berkheya setifera......	1,504
Hyparrhenia hirta......	27,227	Panicum natalense.....	1,180
Digitaria tricholaenoides	24,560	Eragrostis plana.......	464
Heteropogon contortus.	22,246		
Monocymbium ceresiiforme	19,277		

Species of less general occurrence include:—

Elyonurus argenteus....	4,349	Eulalia villosa.........	585
Helichrysum simillimum	2,879	Hypoxis rigidula.......	578
Eragrostis chloromelas.	1,187	Senecio coronatus......	378
Anthospermum rigidum	1,057	Eragrostis capensis.....	23
Pentanisia prunelloides.	915		

and many more, the number of species in the Relative Abundance Table being 220. As in the Piet Retief Sourveld, forbs are plentiful and showy in Spring, e.g.:—

Senecio scleratus.
Acalypha angustata.
Indigofera oxytropis.
I. hilaris.
I. hedyantha and others.
Chascanum latifolium.
Eriosema salignum.
E. burkei and others.
Berkheya echinacea.
Royena galpinii.
Lasiosiphon nanus and others.
Tephrosia macropoda.
Hypoxis argentea.
Alysicarpus zeyheri.
Aeschynomene micrantha.
Ceropegia scabriflora.
Asclepias aurea.
Pelargonium aconitophyllum.
Phyllanthus glaucophyllus.
Arthrosolen microcephalus.
Erythrina zeyheri.
Sphenostylis marginata.
Gerbera aurantiaca and others.
Vigna triloba.
Aster luteus.
Becium obovatum.
Triumfetta hirsuta.
Cissus spinosopilosus.
C. diversilobatus.
Zornia tetraphylla.
Euryops laxus.
E. setilobus.
Haemanthus amarylloides.

and a lot more.

Scrub forest relicts are similar to those of the Piet Retief Sourveld, but merge downwards into the Lowveld in the valleys.

65. THE SOUTHERN TALL GRASSVELD.

(See Taljaard, Photo 113.)

This veld type and the Sour Sandveld are closely related to the Northern Tall Grassveld, but less tropical as regards their bush relicts. The Southern

Tall Grassveld, being dominated by *Themeda* and *Hyparrhenia*, is the least sour of the three. Rainfall ranges from 25–35 inches per annum, falling in summer. The ferocity of the thunderstorms in this region is not to be matched in other parts of the Union. Altitude ranges from 2,000–4,500 feet, though below 3,500 feet the veld is transitional to the Valley Bushveld and 'Ngongoni veld.

The main block of this veld is in Natal at altitudes ranging from 3,500–4,500 feet. Here it is an open savannah of *Acacia woodii* in sourish mixed grassveld with plentiful patches of *Hyparrhenia hirta* and other species of *Hyparrhenia*. Soils resemble those of the Dohne Sourveld in having an erodible subsoil, but the top soil is much shallower (12–18 inches) so that erosion is severe in this veld type. *Themeda* and *Hyparrhenia* are most abundant on dolerite, and most of the outliers of the Southern Tall Grassveld are on dolerite. Hillsides and the deeper valleys have an *Acacia caffra*-savannah, which is marginal to the Valley Bushveld, and often, on south and east aspects, scrub-forest, which merges into the Valley Bushveld downwards and into the Highland Sourveld forest upwards. This *Acacia caffra*-savannah appears to be natural, but is slowly spreading up the valleys, accompanied by thickets of *Acacia arabica* var. *kraussiana*. There are indications that the natural vegetation of the flat, exposed parts of this veld type may have been scrub forest, perhaps rather clumpy around *Acacia woodii* trees.

Species of general occurrence in the southern tall grassveld are:—

Themeda triandra	411,720	Brachiaria serrata	6,844
Hyparrhenia hirta	141,995	Cymbopogon excavatus	3,515
Tristachya hispida	103,178	Cynodon dactylon	3,514
Heteropogon contortus	73,390	Helichrysum rugulosum	3,175
Eragrostis chalcantha	43,601	Andropogon amplectens	2,459
Trachypogon capensis	33,825	Acalypha peduncularis	1,674
Eragrostis chloromelas	23,535	Scabiosa columbaria	1,040
Elyonurus argenteus	22,496	Setaria nigrirostris	906
Eragrostis plana	21,457	Pentanisia prunelloides	648
Microchloa caffra	20,130	Aristida barbicollis	448
Sporobolus capensis	11,372	Rhynchosia totta	408
Eragrostis capensis	8,642	Berkheya sp. (=A.10117)	14

Species of less general occurrence include:—

Digitaria tricholaenoides	26,712	Sporobolus stapfianus	1,067
Hermannia depressa	5,469	Andropogon appendiculatus	988
Setaria flabellata	4,651	Zornia tetraphylla	840
Thesium costatum	1,261	Fimbristylis monostachya	782
Hoffmannseggia sandersonii	1,185	Cymbopogon plurinodis	582

and many more, the number of species in the Relative Abundance Table being 512.

Typical species in the scrub forest are the following (the arrows in this case indicate whether the particular species is more common towards the temperate forest or towards the valley bushveld):—

Dombeya cymosa. ↓
Rhoicissus cuneifolius.
Hippobromus pauciflorus.
Rhus dentata var. grandifolia. ↑
Aloe arborescens.
Ficus burtt-davyi.
Rhus rehmanniana.
Buddleja dysophylla.
Greyia sutherlandii. ↑
Commiphora harveyi.
C. caryaefolia.
Heeria paniculosa.

Acacia caffra.
A. karroo.
A. arabica var. kraussiana.↓
Cussonia spicata.
Gymnosporia buxifolia.
Tarchonanthus camphoratus.↓
Euclea lanceolata.
Grewia occidentalis.
Rhus pentheri.↓
Allophylus decipiens.
Ziziphus mucronata.↓
Celtis kraussiana.
Pavetta cooperi.
Dais cotinifolia.
Buddleja salicifolia.↓
Jasminum angulare.↓
Cassinopsis ilicifolius. ↑
Canthium ciliatum. ↑
Halleria lucida. ↑
Olinia sp. ↑
Calpurnia woodii. ↑
C. intrusa.↓
C. subdecandra.
Trimeria trinervis.
Gymnosporia peduncularis. ↑
Clausena anisata.
Leonotis intermedia.
Rhamnus prinoides
Rubia petiolaris.↓
and many more.

On the slopes of the Biggarsberg and northwards, is a transition to the Northern Tall Grassveld. Traces of the Southern Tall Grassveld are to be found in valleys south of the limit shown on the map. e.g. the valleys of the Upper Keiskama, Tyumie and Mancazana Rivers.

66. NATAL SOUR SANDVELD.

This veld type occurs in the basins of the Waschbank, Buffalo and Upper White Umfolosi Rivers on badly drained, shallow, sandy soil. It is generally a very open savannah of *Acacia woodii* in a poor sourveld; only in parts, particularly where streams debouch from the kloofs on to the plains, does *Acacia woodii* become plentiful. The scrub forest of the hills is similar to that of the Southern Tall Grassveld, but rather more tropical.

Altitude ranges from 3,000–4,500 feet and rainfall from 24–35 inches per annum, falling in summer.

Species of general occurrence are:—

Tristachya hispida......	219,815
Digitaria tricholaenoides	209,424
Eragrostis chalcantha...	102,122
Heteropogon contortus.	96,064
Elyonurus argenteus....	42,537
Hyparrhenia hirta......	28,323
Cynodon dactylon......	24,867
Trachypogon capensis..	22,952
Helichrysum simillimum	18,520
Eragrostis chloromelas.	14,466
Monocymbium ceresiiforme	13,231
Aristida junciformis....	12,641
Andropogon filifolius...	10,990
Microchloa caffra.......	9,345
Paspalum commersonii var.	6,844
Eragrostis nebulosa.....	5,942
E. gummiflua...........	4,674
Brachiaria serrata.......	4,610
Helichrysum rugulosum.	3,877
Andropogon eucomus...	3,508
A. amplectens..........	2,744
Loudetia simplex.......	2,512
Andropogon schirensis..	2,075
Eragrostis plana........	1,746
Panicum natalense......	870

Species of less general occurrence include:—

Themeda triandra......	17,933
Andropogon appendiculatus	17,561
Sporobolus capensis....	7,270
Fimbristylis complanata	4,111
Digitaria monodactyla..	3,293
Setaria nigrirostris......	1,044
Helichrysum caespiticium	671
Eragrostis capensis......	564
Harpechloa falx........	470
Cymbopogon excavatus.	390
Dicoma anomala.......	221

Aristida barbicollis.....	3,191
Eragrostis sclerantha...	2,333
Anthospermum rigidum	1,270
Pogonarthria squarrosa.	1,180
Alloteropsis semialata var. ecklonii.	1,081
Urelytrum squarrosum..	176
Pentanisia prunelloides..	52
Cassia mimosoides......	17

and many more, the number of species in the Relative Abundance Table being 157.

Extensive areas are waterlogged in summer; here *Andropogon eucomus*, *Imperata* and a variety of sedges and rushes are important constituents of the veld.

The best seasons for mapping these grassy veld types are autumn and winter, when they are more or less dry, because then the distinctive colours of the dominant grasses show up better—thus *Themeda* is purple-pink, *Elyonurus* yellow, *Hyparrhenia* cream, *Eulalia* dark red-brown, *Tristachya*, *Loudetia* and *Digitaria tricholaenoides* grey, *Andropogon amplectens* mauve, *A. schirensis* purple-brown, *Eragrostis plana*, *E. chloromelas* and *E. curvula* white, and so on. In spring, when the veld in green, these differences in colour are very much less evident.

67. PIETERSBURG PLATEAU FALSE GRASSVELD.

The climax of this plateau is clearly open, clumpy Sourish Mixed Bushveld, with *Acacia rehmanniana* as the typical tree. Altitude ranges from 4,000–5,000 feet and rainfall from 15–23 inches per annum, falling in summer. The rock is granite.

The principal species are:—

Themeda triandra.
Hyparrhenia hirta.
Heteropogon contortus.
Aristida canescens.
A. diffusa var. burkei.
Trachypogon capensis.
Schizachyrium semiberbe.
Elyonurus argenteus.
Andropogon schirensis.
Eragrostis chloromelas.
Eragrostis chalcantha.
Brachiaria serrata.
B. nigropedata.
Eragrostis superba.
Sporobolus nitens.
Triraphis andropogonoides.
Digitaria argyrograpta.
Cymbopogon plurinodis.
C. excavatus.

Acacia rehmanniana, *A. heteracantha*, *A. stolonifera* and *Gymnosporia senegalensis* occur scattered through it, with *Acacia permixta* along its northern margin where it merges into the Open *Sclerocarya* Veld. *Aristida barbicollis* is abundant in tramped out parts.

68. EASTERN PROVINCE GRASSVELD.

Surviving good samples of this veld show it to be one of the densest grassveld types in the Union. It lies on undulating country, at altitudes ranging from 1,800–3,000 feet, along the foot of the mountains from Bruintjieshoogte to Debe Nek. Rainfall ranges from 14–25 inches per annum, falling mostly in summer. Extensive patches still remain as grassveld, but most of it is becoming invaded by thornveld and Karoo. It is included amongst the false grassveld types because it is suspected that the climax is temperate scrub forest.

Species of general occurence are:—

Themeda triandra.....	540,000
Eragrostis chloromelas.	372,679
Digitaria argyrograpta.	218,000
Microchloa caffra.....	216,120
Heteropogon contortus	116,130
Eragrostis obtusa.....	57,670
Tragus koelerioides....	11,301
Cymbopogon plurinodis	5,360
Sporobolus fimbriatus.	5,340
Cynodon incompletus.	4,325
Eustachys paspaloides...	3,366
Aster muricatus.........	2,280
Pelargonium sidaefolium	1,926
Helichrysum dregeanum.	1,622
Hermannia candicans...	442
Selago triquetra.........	300
Eragrostis curvula......	177
Hibiscus atromarginatus	168
Sutera pinnatifida forma	35
Acacia karroo..........	17

Species of less general occurrence include:—

Panicum stapfianum.....	3,900
Helichrysum rugulosum..	1,800
Anthericum dalyae......	1,600
Eragrostis capensis......	1,600
Blepharis integrifolia....	880
Mariscus dregeanus......	832
Argyrolobium pauciflorum	808
Crassula turrita.........	803
Mariscus capensis.......	803
Cyanotis nodiflora......	541
Cyperus usitatus........	461

and many more, the number of species in the Relative Abundance Table being 152.

Under conditions of selective overgrazing this veld breaks down to *Digitaria argyrograpta, Eragrostis obtusa, E. chloromelas, Sporobolus fimbriatus* and *Tragus koelerioides*, which may be quite dense, but not so dense at ground level as to keep out Karoo bushes, e.g. *Nenax microphylla, Sutera pinnatifida forma, Nestlera humilis, Gamolepis trifurcata, Selago triquetra, Pelargonium abrotanifolium, Walafrida saxatilis* and *Pentzia incana*.

Under conditions of continuous grazing so heavy as to be relatively non-selective, *Microchloa* tends to replace *Themeda*, etc., growing very densely, with stunted *Aster muricatus* and smaller quantities of very short *Hermannia candicans, Helichrysum dregeanum, Sporobolus discosporus* and *Aristida barbicollis.* If such veld were rested, the growing out of these stunted Karoo species might give the superficial observer the impression that the effect of resting is to bring in the Karoo.

It should be noted that there is more of this veld below Bedford and Kroomie than is shown on the map.

VII.—SCLEROPHYLLOUS BUSH TYPES.

69. Macchia.

(See Marloth I, Pl. 22, 27, 36, Fig. 80; II, 1, Pl. 14; II, 2, Pl. 72; III, 1, Pl. 1, 6, 28, Fig. 60B, Pl. 38; III, 2. Pl. 58, Figs. 105, 109; IV, Pl. 4A; Taljaard, Photo 18; Reynolds, Pl. 77; Hutchinson, facing p. 64; Adamson, Photos 1, 2.)

This vegetation type, usually known as Fynbos, is the southern vegetation, different in origin and nature from the tropical vegetation, but to-day very much mixed up with it. It is a complex vegetation, and to divide it simply into Macchia and False Macchia is like dividing the tropical vegetation into grassveld and bushveld, i.e. in this preliminary map and description we are not really subdividing this southern vegetation in the same way as we have subdivided the tropical vegetation.

In the case of the tropical vegetation, forest, bushveld and grassveld are each dominated by a few *species*, which occur all through each of these vegetation types, combining in varying proportions to form the veld types. In the case of the southern vegetation, there is no such dominance of a few *species*. This might be interpreted as indicating that the southern vegetation is the older. The best we can do is to draw up a list of *families* and *genera* occurring as dominants in all the variations of the fynbos, thus:—

PROTEACEAE.

Protea.
Leucadendron.
Leucospermum.
Serruria.
Paranomus and others.

ERICACEAE.

Erica.
Simocheilus.
Philippia.
Blaeria and others.

LEGUMINOSAE.

Aspalathus.
Podalyria.
Cyclopia.
Amphithalea and others.

RESTIONACEAE.

All genera.

CYPERACEAE.

Tetraria.
Ficinia.
Chrysithrix and others.

GRAMINEAE.

Danthonia.
Pentaschistis.
Ehrharta.
Plagiochloa.
Lasiochloa and others.

RHAMNACEAE.

Phylica.

PENAEACEAE.

All genera.

RUTACEAE.

Diosma.
Agathosma.
Acmadenia.
Macrostylis and others.

ROSACEAE.

Cliffortia.

BRUNIACEAE.

Brunia.
Berzelia.
Tittmannia and others.

GERANIACEAE.

Pelargonium.
Monsonia and others.

HAEMODORACEAE.

Wachendorfia.
Cyanella.
Dilatris and others.

LILIACEAE.

Ornithogalum.
Bulbinella.
Dipidax.
Lachenalia and others.

ORCHIDACEAE.

Disa.
Acrolophia.
Satyrium and others.

COMPOSITAE.

Metalasia.
Ursinia.
Othonna.
Euryops.
Helipterum.
Helichrysum.
Stoebe.
Elytropappus.
Cullumia.
Pteronia.
Pentzia.
Senecio.
Corymbium.
Eriocephalus and others.

THYMELEAEACEAE.

Gnidia.
Passerina.
Cryptadenia and others.

AIZOACEAE.

Acrosanthes.
Pharnaceum.
Polpoda and others.

BORRAGINACEAE.

Lobostemon.
Echiostachys.

VERBENACEAE.

Stilbe.
Campylostachys.

CAMPANULACEAE.

Lightfootia.
Prismatocarpus.
Lobelia.
Merciera and others.

POLYGALACEAE.

Polygala.
Muraltia.
Mundia.

GRUBBIACEAE.

Grubbia.

AMARYLLIDACEAE.

Amaryllis.
Nerine.
Gethyllis.
Hypoxis.
Brunsvigia and others.

IRIDACEAE.

Moraea.
Homeria.
Gladiolus.
Lapeyrousia.
Sparaxis.
Ixia.
Tritonia.
Watsonia.
Micranthus.
Romulea.
Anapalina.
Pentamenes.
Geissorhiza and others.

Any typical sample of Fynbos will have most, if not all, of these genera and a lot more, but the majority of the species will vary from mountain to mountain.

The Fynbos is particularly associated with sandstone and poor, white, sandy soil in regions receiving a winter rainfall. It requires at least 10 inches of rain per annum. Two broad divisions are usually recognized; Fynbos and Arid Fynbos. The latter is particularly interesting as tending to develop, under conditions of grazing mismanagement, a generic composition much like that of the Karroid False Fynbos that invades the grassveld of the mountains of the Upper Plateau, in which such typical families as Proteaceae, Rutaceae and Ericaceae are poorly represented or not at all.

In the wetter, warmer parts, the Fynbos succession leads on, via tall *Protea*, *Leucadendron*, *Podalyria*, *Aspalathus*, *Chrysanthemoides*, *Virgilia* and others to *Podocarpus* and *Widdringtonia* forest, but a great number of tropical species also have a place in this succession and climax, except on the Cedarberg. There seems to be little place for grassveld in this succession, though there are a few indications that more than one kind of grassveld is possible, quite apart from the invading tropical grassveld. It is probable that the Restionaceae have replaced a lot of grass, especially at higher altitudes. The replacement of the shaly parts of it by Rhenosterbosveld has already been mentioned (p. 118).

This brief outline of the Macchia will have to suffice at this stage.

VIIA.—FALSE SCLEROPHYLLOUS BUSH TYPES.

70. FALSE MACCHIA.

[See Hutchinson, facing p. 321 (Grahamstown).]

Most of this veld type is to-day indistinguishable from the true Macchia, but there are plenty of indications that in its natural condition it would have been transitional from the Dohne Sourveld to the Macchia, and much resembling the veld of the summits of the Amatolas and Katberg. Wetter southern aspects would have had a transitional forest climax. The dominance of *Aristida junciformis* and other tropical grassveld species in the neighbourhood of Swellendam has already been mentioned (p. 35), as has the grassiness of the eastern part of this veld type (p 15), where the process of conversion of a sour grassveld into Fynbos can be seen going on.

Beyond pointing out the dominance of Composites (*Othonna*, *Euryops*, *Ursinia*, *Gamolepis*, etc.) in parts of this veld on northern aspects after burning, which may be taken to foreshadow the dominance of Composites in the derived non-succulent Karoo, we will leave a discussion of it for another occasion.

BIBLIOGRAPHY.

Adamson, R. S. .... “The Vegetation of South Africa”. 1938.

Bews, J. W. .... “Plant Forms and their Evolution in South Africa” 1925.

Brooks, C. E. P. .... “Climate through the Ages”. 1926.

Brown, J. C. .... “The Hydrology of South Africa”. 1875.

Cannon, W. A. .... “General and Physiological Features of the More Arid Portions of Southern Africa, with Notes of Climatic Environment.” *Carnegie Institute.* 1924.

Dyer, R. A. .... “The Vegetation of the Divisions of Albany and Bathurst.” *Botanical Survey Memoir No.* 17. 1937.

Hutchinson, J. .... “A Botanist in Southern Africa.” 1946.

Irvine, L. O. F. .... “The Major Veld Types of the Northern Transvaal and Their Grazing Management.” (Unpublished.)

King, L. C. .... “South African Scenery.” 1942.

Kokot, D. F. .... “An Investigation into the Evidence Bearing on Recent Climatic Changes over Southern Africa.” *Irrigation Department Memoir*, dated 1948, published in 1950.

Marloth, R. .... “The Flora of South Africa.” 1913.

Pentz, J. A. .... “An Agro-ecological Map of Natal” (with a map of the Union). 1949.

Phillips, J. F. V. .... “Forest-succession and Ecology in the Knysna Region.” *Botanical Survey Memoir No.* 14, 1931.

Pole Evans, I. B. .... “A Vegetation Map of South Africa.” *Botanical Survey Memoir No.* 15, 1936.

Reynolds, W. G. .... “The Aloes of South Africa.” 1950.

Schulze, B. R. .... “The Climates of South Africa according to the Classifications of Köppen and Thornthwaite.” *South African Geographical Journal.* 1947.

Staples, R. R. and Hudson, W. K. “An Ecological Survey of the Mountain Area of Basutoland.” 1938.

Taljaard, M. S. .... “Oor Berge en Vlaktes.” 1948.

Tidmarsh, C. E. M. .... “Conservation Problems in the Karoo.” *Farming in South Africa.* August, 1948.

West, O. .... “The Vegetation of Weenen County, Natal.” *Botanical Survey Memoir No.* 23, 1951.

White, A., Dyer, R. A. and Sloane, B. “The Succulent Euphorbieae.” 1941.

INDEX TO SPECIES AND GENERA.

In this Index the following information is given, in this order:—

1. The value of the species. This is indicated by symbols:—

B. Undesirable plants which should be reduced in number by appropriate veld management.

BB.—Undesirable plants which should, or may have to, be eradicated by mechanical means.

P.—Poisonous plants of economic importance.

G.—Valuable plants to be encouraged by appropriate veld management.

GG.—Valuable plants which should, or may have to, be encouraged by reseeding.

All the rest, to which no symbol is attached, are the ordinary plants which make up the bulk of the vegetation, neither outstandingly good nor outstandingly bad. Had the vegetation consisted only of first-class grazing plants, South Africa would long since have become a total desert.

2. The numbers of the specimens on which the writer's knowledge of the species is based. In practically all cases the determinations were made by the National Herbarium, except for the Mesems., which were determined by Dr. Bolus at the Bolus Herbarium from fresh material sent by post. The necessary cartons and boxes were provided by various storekeepers, to whom thanks are due.

3. The pages on which the species or genus is mentioned.

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